OPENING CEREMONY OF THE TROPICAL PRODUCTS INSTITUTE BY

H. R. H. The Prince Philip Duke of Edinburgh,

K.G., K.T., G.B.E.

ON THE AFTERNOON OF MAY 6th, 1958, the Tropical Products Institute was honoured by the presence of His Royal Highness The Prince Philip, Duke of Edinburgh, who visited the new building in Gray's Inn Road, London, to perform its opening ceremony and afterwards to inspect the Institute and the work being carried on. The building, comprising 46,000 sq. feet of floor space, was erected on a bombed site and subsequently fitted out to good modern standards by the Ministry of Works, providing accommodation into which the Director and staff were proud to welcome the Royal Visitor on this memorable occasion.

The opening ceremony itself took place in the Institute's conference and lecture room on the sixth floor, in the presence of many distinguished persons. On the dais with Prince Philip were the Secretary of State for the Colonies, Mr. Lennox-Boyd; the Lord President of the Council, Lord Hailsham; the Mayor of Holborn, Aldermen Ridd; the Member of Parliament for St. Pancras, Mrs. L. M. Jeger; the Chairman of the Colonial Products Council, Sir Charles Dodds; the Director of the Tropical Products Institute, Dr. R. A. E. Galley; and the Permanent and Deputy Under-Secretaries of State at the Colonial Office, Sir John Macpherson and Sir Hilton Poynton. Among those also attending the ceremony were representatives of Commonwealth countries; members of the Colonial Products Council and Chairmen of the Institute's consultative

committees; representatives of the Treasury, the Office of the Lord President, the Colonial Office, the Commonwealth Relations Office, the Ministry of Works, and various Government scientific organizations and members of the Institute's own staff—about one hundred and twenty-five in all.

The proceedings started with the presentation to His Royal Highness of members of the Colonial Products Council and this was followed by a short speech from Sir Charles Dodds, the Council's Chairman, who asked Prince Philip if he would be pleased to perform the opening ceremony. His Royal Highness in a witty, but at the same time most inspiring speech said:

"*Ministers, Ladies and Gentlemen,*

"Openings are seldom what they seem. In recent years I have opened quite a number of places and it nearly always turns out that the places have been in use for years already. I am glad to say that the Tropical Products Institute is no exception, although in this case a rather different kind of deception has been perpetrated. I know that this building has not been in use very long, and that the name Tropical Products Institute is fairly new, but the organization has been functioning under a series of different names and in another place since 1894! Instead of 'open' I think perhaps in this case 'reconstituted' or, if that reminds you too much of dried eggs, 'recreated' might be a better word to use. But since those early days, the organization has gone from strength to strength and from success to success both in the quality and in the scope of the work tackled. The Annual Report, which I studied before I came here, and the Summary of Inquiries for three months of last year, show a most impressive record of work done, and the success of the Institute is naturally measured by such obvious results, but there is much more value to this work than the purely obvious. Investigations lead to new possibilities, to new products, to more work, more machinery, more trade and a higher standard of living all round. It is establishments such as this that prime the pump of expansion in the developing countries of the world, and it only seems rather sad to me that it does not do work for all tropical countries.

"Now, I do not pretend to have any special knowledge of the Colonies, but I hope that this Institute will always have a particular care and thought for the smaller Colonies. Their problems may not be very interesting or important but their livelihood means just as much to them as it does to the rest of us. Their disadvantages are their lack of size and their lack of resources and they may not be very good at helping themselves and this Institute can do literally wonders for them.

"Now I need hardly add that the Institute has a lot to offer

every country of the Commonwealth, but I hope it will not sit back and wait for the customers to roll up. I hope it will develop such a passion for improvement, and such a confidence in its own abilities, that it will send out into all the tropical countries of the Commonwealth, offering to solve their problems for them. And so today I am delighted to declare this building open and to wish the Tropical Products Institute a long and fruitful future."

After this speech His Royal Highness unveiled a bronze plaque commemorating the occasion. The Director, in reply, thanked His Royal Highness for the great honour he had accorded the Institute on this occasion, and then invited him to make a tour of inspection of the building.

On leaving the conference room, Prince Philip was first shown the accommodation on the sixth floor which will ultimately be developed as a small museum to exhibit the range of products with which the Institute is concerned. The Royal Party then by-passed the fifth floor, which is devoted almost entirely to administrative offices, and proceeded to the spacious and well-appointed main library where His Royal Highness signed the Visitors' Book. This had been made in the Institute's bookbinding shop, best Nigerian goatskin being used for the covers. The main library, which occupies a large part of the fourth floor of the building, houses about one-third of the Institute's very large and unique stock of literature on the agriculture and plant and animal products of the tropics. It is pleasingly furnished in light oak with its bookcases well spaced so that desks and chairs can be placed between them for study purposes. Members of the specialist public are allowed to visit and work in this part of the library and visitors from the tropics are always particularly welcome.

Prince Philip next visited the technical index section containing some half a million cards of references to technical literature on tropical agriculture and products, which have been compiled over the last fifty years.

Finally on the fourth floor, His Royal Highness inspected the laboratory which deals with pesticides and drugs of vegetable origin. This laboratory with its associated office, is typical of the accommodation provided for each of the Institute's eight advisory sections, whose function it is to answer questions on tropical products received from inquirers at home and overseas and, where necessary, to carry out in the laboratories chemical and physical investigations on samples submitted.

On the third floor the Royal Party visited the advisory sections devoted to animal by-products and tanning materials and to fruit and fruit products. In the first of these two laboratories, Prince

Philip saw work that was being carried out for Sarawak on tanning materials from mangrove bark; in the second he inspected a number of tropical fruits and nuts which were being examined from the point of view of their quality and acceptability for the United Kingdom market. He also inspected the bookbinding shop and the subsidiary library.

The second floor of the Institute is devoted mainly to laboratories for more fundamental research. This is work which has only recently been undertaken by the Institute and for which staff is currently being recruited. This floor houses also the advisory section dealing with foods, oils, fats and waxes, and this the Duke inspected. He also saw the pyrethrum laboratory where the work being conducted on this important export crop of East Africa was described to him. From there, His Royal Highness went to the physical chemistry laboratories and examined some of the elaborate equipment which they contain. Finally on this floor, a demonstration was staged of the work going on in the fibres section, showing in particular the microscopical examination and identification of vegetable fibres such as jute and jute substitute fibres.

On the first floor, Prince Philip was shown the advisory section concerned with essential oils, spices, gums and resins, to which is connected a portion of the pilot plant laboratory housing the larger-scale essential oil stills. His Royal Highness showed particular interest in the gas chromatography equipment, the development of which has proved of great importance to this section. On the first floor, too, there are certain common facilities such as a special equipment laboratory, a fireproof room for solvent recovery and overnight experiments, a chromatography suite, a sample-grinding room, and a first-aid room.

Finally, the techniques of pulping a timber and of the preparation of standard sheets of paper from pulp were shown to His Royal Highness who then inspected the laboratory's constant temperature and humidity room, where the various physical tests of quality which are applied to such standard sheets were demonstrated. The Duke himself operated a printing machine which is used for printability tests. The ground floor of the building also houses the workshop and the pilot plant laboratory. The pilot plant laboratory has been specially constructed so that tall equipment can be built and operated in it.

After his tour of the building, His Royal Highness returned to the conference room to have presented to him representatives of the Treasury, Colonial Office and the Ministry of Works, and to take tea with the assembled company.

THIS PLAQUE COMMEMORATES
THE OPENING OF THE
TROPICAL PRODUCTS INSTITUTE
ON MAY 8TH 1958 BY
H.R.H. THE PRINCE PHILIP
DUKE OF EDINBURGH K.G. K.T. G.B.E.

PLATE I: The plaque in the Conference Room commemorating the Official Opening

facing page 4

PLATE II: Prince Philip signs the Visitors' Book

PLATE III: Prince Philip examining the polarograph in the Insecticides and Drugs Laboratory

PLATE IV: General view of the Main Library

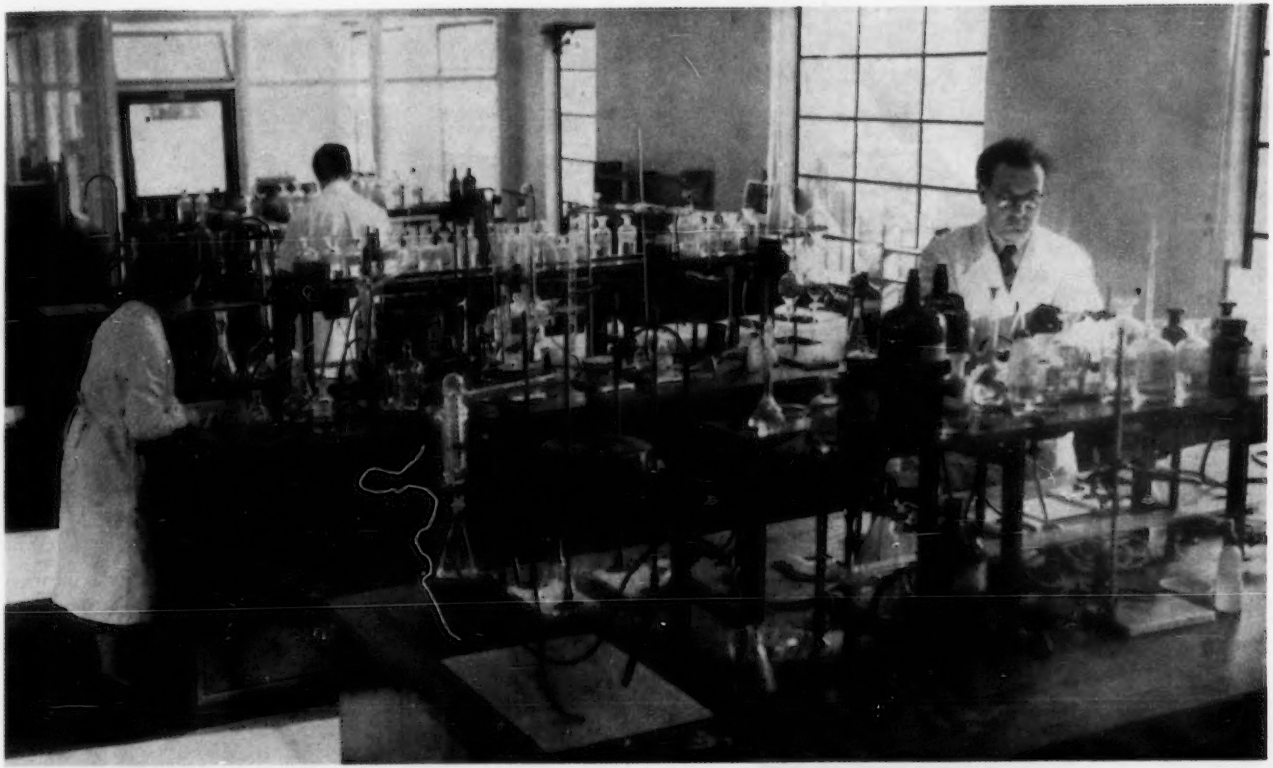

PLATE V: The Insecticides and Drugs Laboratory

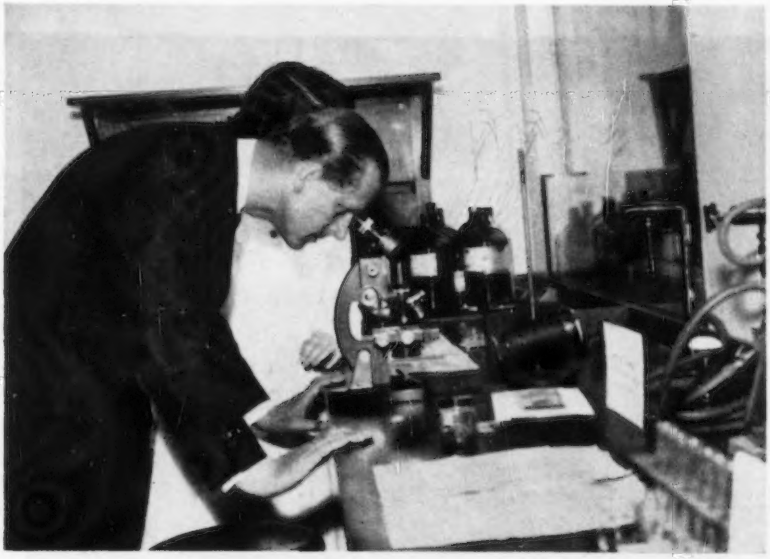

PLATE VI: Microscopical examination of Pyrethrum flowers

PLATE VII: His Royal Highness chats with the Bookbinders

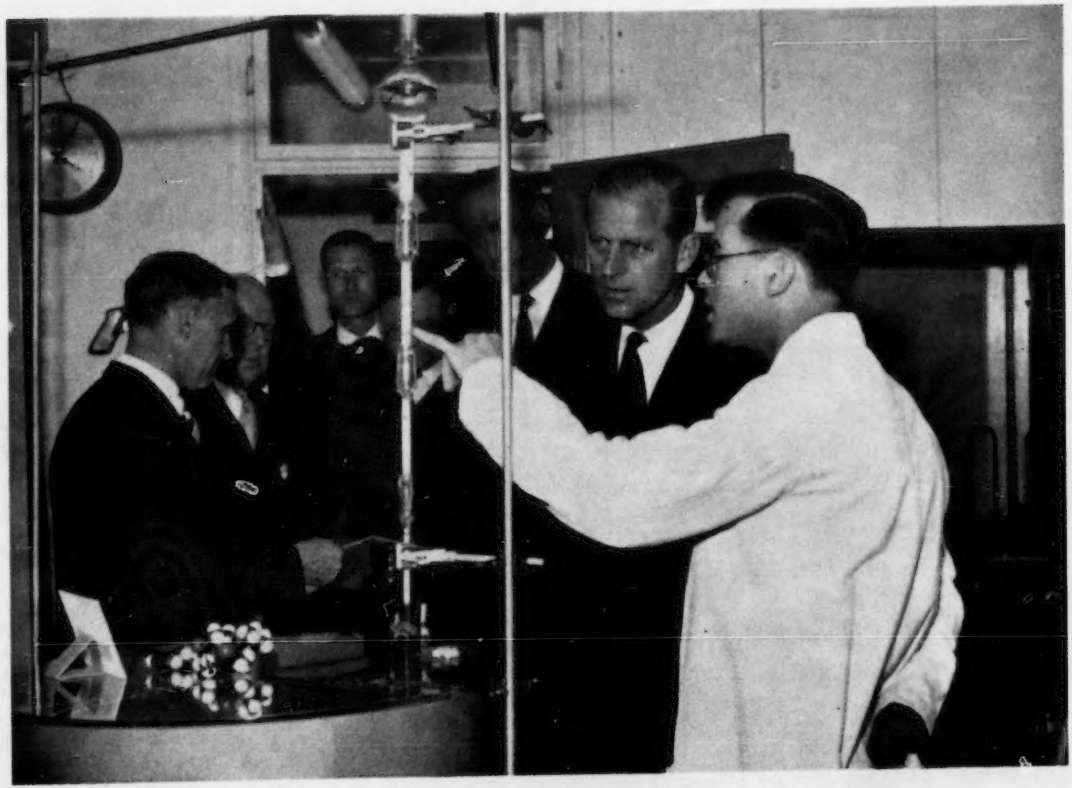

PLATE VIII: Separation of pyrethrins in an alumina displacement column

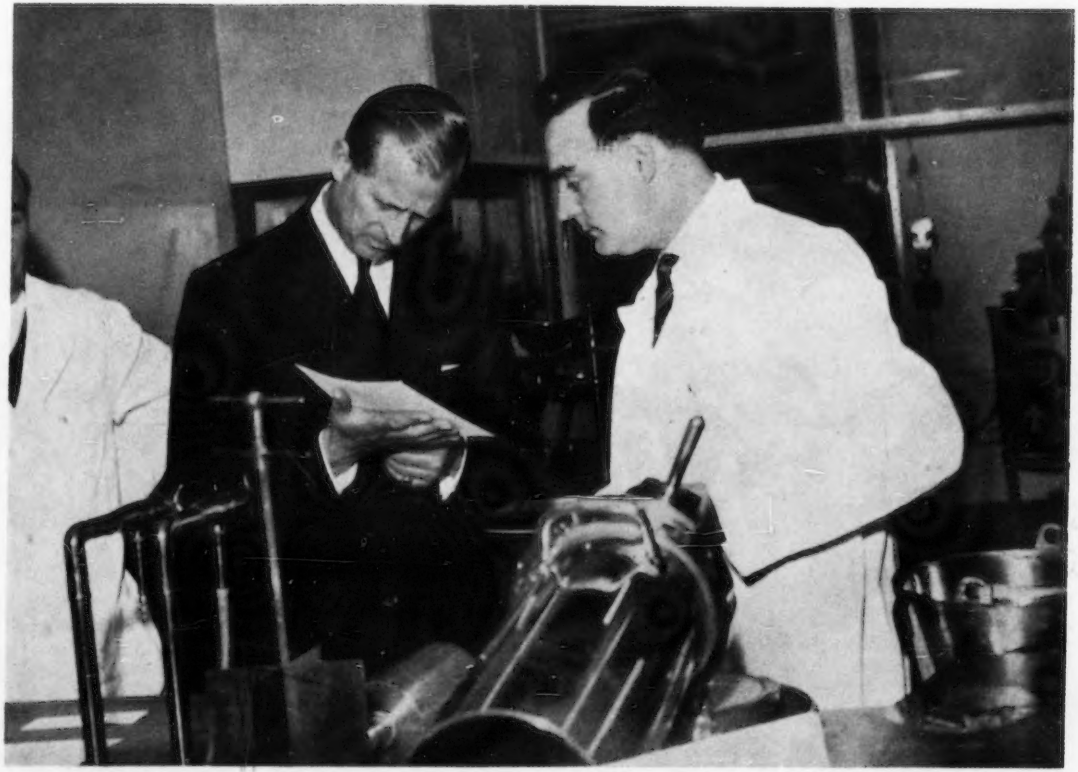

PLATE IX: Prince Philip examines a standard sheet made from pulp from the Trumpet Tree (*Cecropia peltata*)

The Production of Hardboard from Tropical Timbers*

IV. Caribbean Pitch Pine *(Pinus caribaea)*

By D. F. Packman

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SUMMARY

Standard and super hardboards to the requirements of B.S. 1142 were made on an experimental scale from Caribbean pitch pine (*Pinus caribaea*) by the Defibrator process. The inclusion of 25 per cent. by volume of highly resinous heartwood had a beneficial effect on the water resistance of the boards without seriously impairing their strength properties. A tendency to uneven colour in the surface of the boards was the only undesirable result of the presence of this proportion of resin in the mixture. The amount which might occur in waste wood, e.g., sawmill waste and forest thinnings, would be unlikely to affect the boards adversely.

INTRODUCTION

Caribbean pitch pine grows in the Bahamas, Western Cuba, British Honduras, Guatemala and Nicaragua. It resembles the American pitch pine (principally *P. palustris* and *P. elliottii*) from the south-eastern United States but is somewhat heavier on the average. The wood is dense, hard and resinous, with an average bulk density of 44 lb./cu. ft. in the seasoned condition.

MATERIAL

This investigation was carried out on wood from a single log of 9 inches average diameter, obtained from British Honduras by the Tropical Products Institute. As received, it had a bulk density of 53 lb./cu. ft. and an average moisture content of 19 per cent. The heartwood was clearly defined and very resinous. With an average diameter of 4·5 inches it represented one quarter of the volume of the total log and contained 22 per cent. resin, on a dry weight basis, soluble in 1 : 2 alcohol-benzene mixture. The resin content of the sapwood was slightly less than 2 per cent.

Although in appearance this log was similar to that used for the examination of *P. caribaea* timber by the Tropical Products Institute, reported on page 22, the large difference between the resin content found by the Tropical Products Institute and that found by the Forest Products Research Laboratory suggests that the logs were, in effect, different samples.

* See also *Colon. Pl. & Anim. Prod.*, 1954, **4**, 293; 1955, **5**, 39 and 137.

EXPERIMENTAL

In the air-dry condition the wood, particularly the resinous heartwood, was very hard. In order to ease the conversion to pulping chips in the laboratory chipper[1,2], billets cut from the log were immersed in water for four days before chipping. Whilst the sapwood was very permeable and rapidly became waterlogged, the heartwood took up no significant amount of water during this time. In spite of this, however, clean-cut chips of uniform quality were produced from both the heart and sapwood.

Pulp was made from the chips by the Defibrator process. In this process, wood chips are reduced to fibre by subjecting them to mechanical defibration while under the influence of steam at high temperature and pressure. The separation of the fibres is effected by a rubbing-apart rather than by grinding and is assisted by the plasticising or softening effect of the steam on the wood. In consequence, the fibres are not cut or substantially weakened. In full-scale machines, the wood is passed continuously between stationary and rotating metal discs with grooved surfaces. The chamber in which the discs rotate is maintained at a temperature of 150°C. to 190°C. by means of high pressure steam, while a system of valves and pressure chambers controls the entry of chips and ejection of fibre. Under optimum conditions, which may vary for different species, the wood is defibred with minimum consumption of power and with minimum damage to the fibres themselves.

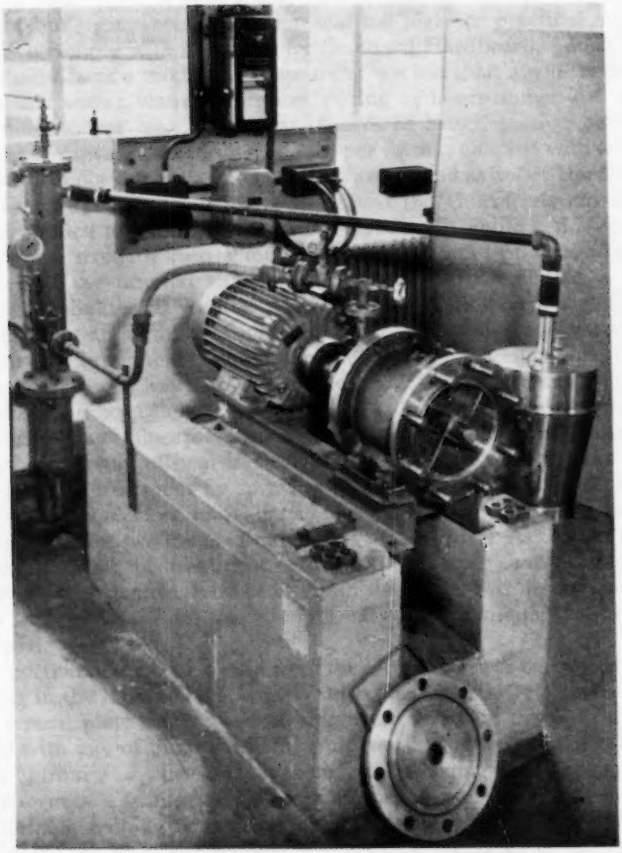
The Laboratory Defibrator used in these experiments (Plate 1) is essentially similar to that originally used and described by Asplund[3], the inventor of the process. Unlike the large-scale machines, it is not designed for continuous working but takes small samples of chips batchwise. It consists of a stainless steel cylinder, connected to a supply of high pressure steam, in which a four-bladed rotor propels chips over the surfaces of five grooved bed-plates. A single batch of chips may be from a half to one lb. in weight, depending on the bulk density of the wood; the duration of treatment is normally 1 to 2 minutes. Data obtained from experiments with this machine may be correlated with full-scale continuous operation of the disc-type Defibrators.

(1) Sapwood

Preliminary pulping trials were made with batches of chips containing sapwood only. A uniform cleanly-defibred product was obtained from chips treated for 2 minutes at 150 lb. per sq. in. steam pressure. In a further series of trials it was found possible to reduce the treating time to 0·5 min. without any apparent deterioration in the quality of the product. In order to ensure reproducibility, however, a standard treating time of 1 minute was adopted for the preparation of a large batch of pulp from 20 separate cooks. Pulp so prepared represented 87 per cent. of the dry weight of the original wood. It was very free and the drainage time for a 5·0 g. sample, measured on the Williams Precision Freeness Tester, was 7·5 seconds.

Sheets 10 inches square were made on the laboratory sheet former[1] from a suspension of this pulp without further refining treatment or

PLATE I



The Laboratory Defibrator

[*facing page* 6

screening. From these, boards of $\frac{1}{8}$-inch thickness were pressed. The pressing conditions were 1,000 lb. per sq. in. at 185°C., for 10 minutes, without any release of pressure for "breathing". The boards were of good appearance and free from "water burns" and other surface blemishes. Average results of tests carried out under standardized conditions [1] are shown in Table I. From these it may be seen that the boards had adequate strength, but their water absorption was too high for practical requirements. To comply with B.S. 1142 for Standard Hardboard, $\frac{1}{8}$-inch thick boards must have a modulus of rupture of not less than 4,900 lb. per sq. in. together with a water absorption, during 24 hours immersion, of not more than 30 per cent. by weight. Boards of better quality, having a modulus of rupture exceeding 5,600 lb. per sq. in., coupled with a water absorption of not more than 20 per cent., are classed as Super Hardboard.

A heat treatment consisting of 2 hours at 180°C. in freely circulating air was applied to some of the boards. As shown in Table I, this resulted in a gain in strength with a reduction in water absorption to approximately half the original value. Heat-treated boards still had a water absorption slightly above the acceptable level, however, and it was apparent that an addition of some form of waterproofing agent would be necessary to bring them within the limits of the Specification. In the course of previous work on other species of wood[4], tempering with linseed oil had been shown to be the most satisfactory of various methods of reducing water absorption since it did not at the same time impair the strength properties of boards. Several of the boards were therefore submitted to this treatment by spraying the required amount of oil evenly over both their surfaces, immediately after leaving the hot press, and then heating them for two hours in circulating air at 180°C. As the test results in Table I show, this treatment with as little as 2 per cent. of linseed oil was effective, bringing the boards within the Super Hardboard range for water resistance, while the strength, already adequate, was further increased.

A portion of the coarse pulp from the Defibrator was taken for further refining in the laboratory Sprout-Waldron disc mill[1]. Trials were made with several plate designs but no significant effect on the pulp was obtained with any of them when the pulp was introduced to the mill as a slurry of from 2 to 5 per cent. consistency. By feeding the coarse material in the form of a semi-dry meal of 30 to 35 per cent. dry fibre-content, a considerable refining action was obtained with plates of a non-cutting profile, No. 12527A, spaced to give a nominal clearance of ·007 to ·010 inch. Water was fed to the mill simultaneously so that the refined pulp was ejected as a 4 to 5 per cent. slurry. Power consumption in the mill was at a fairly high level and was kept constant by suitable small adjustments in the rate of feed of the coarse fibre. A large decrease in freeness was brought about by this treatment, the refined pulp having an average drainage time of 95 seconds for 5·0 g. This degree of refinement was secured without the formation of large quantities of extreme "fines", however, and there was no significant loss in yield during subsequent sheet forming as a result. Although such a drainage time would be too slow for the usual practical requirements of larger scale operation, the

treatment was satisfactorily reproducible and pulps with intermediate freeness could readily be prepared by blending the refined and unrefined fractions. Boards were made from such a blended mixture which had a drainage time of 20 seconds for 5·0 g., as well as from the refined pulp alone. It was found possible to press the partially refined pulp sheets for 10 minutes at 1,000 lb. per sq. in. and 185°C. without any "breathing". The fully refined pulp, however, required breathing in the press to avoid the formation of "water burns" and steam blisters on the surface of the board. A good finish was obtained by modifying the pressing schedule to include a temporary reduction of pressure, down to 50 lb. per sq. in., for 30 seconds after completion of the first full minute in the press at 1,000 lb. per sq. in. The necessity to "breathe" a board during pressing always results in somewhat lower strength properties than would otherwise be obtained. Nevertheless, as the test results in Table I show, boards made from the refined pulp as well as those from the partially refined mixture were somewhat stronger than those made from the original unrefined material. Their water absorption was a little lower and in both cases it was possible to bring them just within the specified limits for Standard Hardboard by heat treatment alone. To enable them to qualify as Super Hardboard some oil tempering was again necessary. Thus the overall practical advantages gained by refining the pulp were small and this step would appear to be unnecessary in order to produce boards to meet the Specification.

(2) Sapwood and Heartwood Mixture

Since insufficient wood was available for a full range of experimental boards to be made from the resinous heartwood alone, further trials were confined to batches of chips containing sapwood and heartwood in the same relative proportion in which they occurred in the original whole log. The resin content of the mixed chips was thus approximately 7·0 per cent. This proportion would probably represent the maximum which might be encountered in large-scale operation. If sawmill waste or forest thinnings were the source of raw material the amount of heartwood, and thus the overall resin content, could be expected to be considerably less.

Twenty batches of mixed chips were treated in the Defibrator and pulp was prepared in exactly the same way as described earlier for the sapwood. Boards were made from the unrefined Defibrator pulp as well as from a partially refined blended mixture, similarly prepared and similar in its physical characteristics to that previously prepared from sapwood alone. It was found possible to press both these pulps without breathing in the press and the test results in Table II were all obtained from boards made in this way. There was a marked tendency in the boards made from the coarse, unrefined, pulp to develop a rather speckled appearance on the surface. This was not due to "water burn" and could not be eliminated by breathing in the press. It was most probably caused by small fragments of solid resin in the pulp suspension which were fused in the hot press and spread out on the surface to form small dark patches.

As might be expected, the boards had considerably lower water

absorption than those from sapwood containing little or no resin. After a hot air treatment alone, boards from both the unrefined and the partly refined pulp were acceptable as Standard Hardboard. Oil tempering with 2 per cent. linseed oil brought them well within the Super Hardboard class. As found earlier for the sapwood, refining the coarse Defibrator pulp again proved to be unnecessary in order to make boards to the requirements of the Specification.

It was thought that the favourable effect of the resin on water resistance might be increased by the addition of alum. Some boards were made, therefore, from both unrefined and partially refined pulp to which alum had been added to the extent of 5 per cent. of the dry weight of the fibre. After pressing and reconditioning, the pH of these boards was from 4·3 to 4·6 whereas all the other boards from both sapwood and sap-heart mixture had a pH of 6·3 to 6·5. As may be seen from Table II, no improvement was affected by this treatment. The water absorption of the alum-treated boards was very much higher than that of untreated boards and strength was considerably lower. Heat treatment effected a much greater reduction in water absorption in the boards containing alum but their strength, though improved, was still considerably below that of heat-treated boards containing no alum.

Conclusions

Good quality hardboard was made by the Defibrator process from Caribbean pitch pine sapwood and from a mixture of sap and heartwood. The inclusion of highly resinous heartwood in proportions up to 25 per cent. of the total wood mixture had no significantly detrimental effect on the strength qualities of the boards and their water resistance was actually improved. The improvement was less marked, however, than has been reported for trials using ponderosa pine and southern pine[5]. The addition of alum to boards containing resinous heartwood had no beneficial effect. On the contrary, it resulted in much lower strength values and higher water absorption. Although the latter could be greatly reduced by subsequent heat treatment, the accompanying restoration of strength was insufficient to make the boards comparable in this respect with those containing no alum. This observed effect was in accordance with results reported for trials carried out on resinous Scots pine[6].

In large-scale operations based on varying mixtures of wood of this species the amount of resin which might occur would be unlikely to have any marked effect on the properties of the boards finally produced. If the amount were very high, a tendency to uneven colour in the surface of the boards might become apparent. Any other influence it might have would be beneficial.

Acknowledgement

The research upon which this communication is based was carried out as part of the programme of the Forest Products Research Board on behalf of the Colonial Products Council. It is published by permission of the Department of Scientific and Industrial Research and the Colonial Products Council.

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(1) Farmer, R. H. and Packman, D. F., "The Production of Hardboard from Tropical Timbers, I". *Colon. Pl. Anim. Prod.*, 1954, **4**, 293-309.
(2) Farmer, R. H. and Packman, D. F., "The Production of Hardboard from Tropical Timbers, II". *Colon. Pl. Anim. Prod.*, 1955, **5**, 39-50.
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(5) Anderson, A. B. and Runckel, W. J., "Utilization of Resinous Wood in Hardboard". *J. For. Prod. Res. Soc.*, 1952, **2**, 76-80.
(6) Anderson, A. B. and Helge, K., "The Influence of Resinous Wood on Hardboard Properties". *Norsk Skogindustri*, 1958, **12**, 3-7.

TABLE I

BOARDS FROM SAPWOOD OF CARIBBEAN PITCH PINE

	Pulp								Boards			
	Yield *per cent.*	Fibre Classification, *per cent.* (Rotating disc screen)						Williams Freeness (5·0 g.) *sec.*	Treatment	Specific Gravity	Modulus of Rupture (*lb./sq. in.*)	Water Absorption *per cent.*
		Above 10 mesh	10/14	14/25	25/52	52/100	Below 100					
Unrefined pulp	87	17	20	25	12	8	18	7·5	Nil	1·06	5,280	63
									Heat only	1·10	7,115	34
									2 per cent. oil	1·15	9,645	19
									3·5 per cent. oil	1·14	10,095	15
Refined pulp		6	15	28	14	10	27	95	Nil	1·11	7,225	51
									Heat only	1·16	8,790	28
									2 per cent. oil	1·12	9,330	16
									3·5 per cent. oil	1·14	9,450	11
Partially refined blended mixture		10	19	30	16	10	15	20	Nil	1·09	6,855	52
									Heat only	1·07	7,240	29
									2 per cent. oil	1·14	8,545	18
									3·5 per cent. oil	1·15	9,610	14

TABLE II

BOARDS FROM CARIBBEAN PITCH PINE CHIPS CONTAINING 25 PER CENT. HEARTWOOD

	Pulp								Boards			
	Yield, *per cent.*	Fibre Classification, *per cent.*						Williams Freeness (5·0 g.) *sec.*	Treatment	Specific Gravity	Modulus of Rupture (*lb./sq. in.*)	Water Absorption *per cent.*
		Above 10 mesh	10/14	14/25	25/52	52/100	Below 100					
Unrefined pulp	86	16	19	27	12	7	19	7	Nil	1·06	4,975	36
									Heat only	1·05	6,300	26
									2 per cent. oil	1·07	8,600	14
									3·5 per cent. oil	1·11	9,760	10
									5 per cent. alum	1·05	3,675	63
									alum + heat	1·06	4,720	14
Partially refined blended mixture		9	17	26	14	9	24	16	Nil	1·10	5,980	30
									Heat only	1·09	7,060	25
									2 per cent. oil	1·09	10,110	14
									3·5 per cent. oil	1·11	10,325	10
									5 per cent. alum	1·09	4,600	56
									alum + heat	1·08	5,750	13

EXPORTS OF ESSENTIAL OILS FROM THE BRITISH COLONIES FOR THE YEARS 1953-57†

	1953		1954		1955		1956		1957	
	lb.	£	*lb.*	£	*lb.*	£	*lb.*	£	*lb.*	£
EAST AFRICA										
Kenya										
Geranium Oil	4,448	17,742	6,897	18,072	6,014	14,990	4,580	12,000	2,188	7,869
Cedarwood Oil	66,852	9,428	53,538	9,691	100,060	23,548	65,062	11,592	103,263	18,270
Other Essential Oils	14,597	2,944	8,880	2,133	7,448	2,774	12,208	6,136	12,268	6,548
Tanganyika										
Lemongrass Oil	408	117	—	—	—	—	—	—	—	—
Bitter Orange Oil	7,416	6,162	5,733	4,430	6,300	4,725	7,272	5,103	8,173	6,202
Geranium Oil	—	—	—	—	—	—	375	978	600	1,910
Other Essential Oils	330	253	—	—	779	1,366	1,257	1,689	1,023	1,422
Uganda										
Geranium Oil	220	347	—	—	—	—	—	—	—	—
Other Essential Oils	—	—	—	—	272	102	—	—	—	—
Zanzibar										
Clove Stem Oil	178,815	99,319	258,832 (b)	143,850	191,211	106,844	179,939	90,757	215,210	85,779
Other Essential Oils	52	18	—	—	—	—	—	—	—	—
INDIAN OCEAN										
Seychelles										
Cinnamon Leaf Oil	218,692	78,449	218,233	104,115	174,090	75,825	208,954	67,460	129,037	41,648
Patchouli Oil	4,440	8,558	602	1,389	962	2,587	1,175	2,042	2,646	3,784
Eucalyptus Oil	46 (a)	38	—	—	—	—	—	—	99	23
Clove Leaf Oil	820	296	—	—	—	—	—	—	—	—

† For earlier statistics, see *Bulletin of the Imperial Institute*, 1948, **46**, 159: also *Colonial Plant and Animal Products*, 1952-3, **3**, 28: 1954, **4**, 24: 1955, **5**, 211. In a few cases, the figures previously published have been revised in the light of more recent information.

(a) *E. citriodora.*

(b) Stated to be Clove Bud and Clove Stem Oils.

	1953		1954		1955		1956		1957	
	lb.	£	*lb.*	£	*lb.*	£	*lb.*	£	*lb.*	£
BRITISH WEST INDIES										
Jamaica										
Grapefruit Oil	6,997	5,965	5,133	4,099	6,197	4,146	5,100	3,656	1,975	1,244
Lemon Oil	1,300	1,282	1,100	975	377	328	750	617	1,475	1,340
Lime Oil	44,446	81,789	31,571	55,243	41,000	53,679	50,796	73,838	38,350	66,022
Orange Oil	103,060	57,750	144,643	57,536	121,950	45,220	124,966	53,319	104,080	46,939
Pimento Oil	95,859	66,558	83,838	58,450	91,919	67,133	62,909	43,383	35,920	20,995
Other Essential Oils	830	718	725	359	—	—	—	—	—	—
Trinidad and Tobago										
Lime Oil (Distilled)	22,103	46,428	6,807	12,316	5,408	8,180	13,547	19,607	6,537	13,284
Lime Oil (Expressed)	490	968	—	—	96	236	622	781	—	—
Other Essential Oils (not including Turpentine)	—	—	—	—	—	—	(c)	(c)	—	—
British Honduras										
Grapefruit Oil	4,731	2,098	6,161	3,115	7,380	3,070	5,110	3,260	1,358	708
Orange Oil	1,820	829	4,964	1,173	9,526	1,532	27,252	4,875	20,569	3,113
Windward Islands										
Dominica										
Bay Oil	26,009	9,457	39,856	15,321	38,348	19,544	48,244	25,600		
Citronella Oil	(c)	(c)	(c)	(c)	2,612	1,507	(c)	(c)		
Grapefruit Oil	315	313	316	313	336	289	(c)	(c)		
Lime Oil (Distilled)	55,463	100,214	34,906	68,006	40,149	64,147	31,616	53,700		
Lime Oil (Ecuelled)	1,080	3,375	1,610	4,316	2,158	6,851	791	(c)	(c)	(c)
Orange Oil (Sweet)	105	101	105	87	616	493	(c)	(c)		
Orange Oil (Bitter)	848	644	—	—						
Essential Oil in solution in Lime Juice	16,287	(c)	1,521	(c)	3,300 (d)	(c)	(c)	(c)		

(c) Information not available.

(d) Lime Oil content of Top Pulp Lime Juice exported estimated at 4 lb. of oil to 100 gallons of juice.

	1953		1954		1955		1956		1957	
	lb.	£	*lb.*	£	*lb.*	£	*lb.*	£	*lb.*	£
Windward Islands (*cont.*)										
Grenada										
Lime Oil . . .	7,068	13,057	10,270	13,351	3,631	5,407	460	605	(c)	(c)
Nutmeg Oil . .	10,260	9,760	4,050	3,780	6,570	7,301	2,385	4,516	(c)	(c)
St. Lucia										
Lime Oil (Distilled) .	3,668	6,960	70	99	1,204	1,142	1,799	2,348	88	154
Lime Oil (Ecuelled) .	172	495	—	—	—	—	—	—	—	—
Leeward Islands										
Montserrat										
Lime Oil (Distilled) .	(c)	(c)	61	124	(c)	(c)	(c)	(c)	(c)	(c)
Lime Oil (Ecuelled) .	699	1,632	248	463	85	150	85	148	(c)	(c)
Bay Oil . . .	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	—	—
British Guiana										
Lime Oil . . .	8,529	15,830	—	—	1,598	2,050	1,179	2,349	300	654
Other Essential Oils (not including Turpentine)	488	241	34	24	83	46	519	246	527	245
ASIA										
Malaya										
Citronella Oil:										
Exports (including re-exports) . .	5,465*	1,060	3,868*	863	37,143*	16,926	83,196*	36,052	75,465*	24,620
Total Imports . .	7,043*	1,545	18,029*	7,731	6,696*	2,850	11,025*	3,792	13,311*	4,578
Excess of Imports over Exports . .	1,578*	485	14,161*	6,868	—	—	—	—	—	—
Excess of Exports over Imports . .	—	—	—	—	30,447*	14,076	72,171*	32,260	62,154*	20,042

(c) Information not available.
* Weights have been calculated from gallons and are, therefore, approximate.

	1953		1954		1955		1956		1957	
	lb.	£	*lb.*	£	*lb.*	£	*lb.*	£	*lb.*	£
ASIA										
Malaya (*cont.*)										
Eucalyptus Oil:										
Exports (including re-exports) . .	4,040*	1,821	7,163*	3,083	6,061*	3,003	6,279*	2,839	5,369*	1,730
Total Imports . .	13,652*	4,664	25,393*	9,360	16,935*	7,439	30,139*	11,427	36,127*	10,199
Excess of Imports over Exports . .	9,612*	2,843	18,230*	6,277	10,875*	4,436	23,860*	8,588	30,758*	8,469
Patchouli Oil:										
Exports (including re-exports) . .	132,393*	247,096	263,960*	495,030	191,400*	344,147	343,817*	419,197	183,893*	218,517
Total Imports . .	121,426*	129,972	260,426*	314,858	285,452*	261,397	233,964*	212,712	213,371*	184,198
Excess of Imports over Exports . .	—	—	—	—	94,052*	—	—	—	29,478*	—
Excess of Exports over Imports . .	10,967*	117,124	3,534*	180,172	—	82,750	109,853*	206,485	—	34,319
Other sorts of Essential Oils (c):										
Exports (including re-exports . . .	21,218*	14,868	73,222*	70,571	57,056*	68,355	49,277*	70,303	146,480*	63,866
Total Imports . .	65,289*	55,399	72,484*	72,605	90,319*	83,352	105,553*	82,075	78,200*	67,960
Excess of Imports over Exports . .	44,071*	40,531	—	2,034	33,263*	14,997	56,276*	11,772	68,280*	—
Excess of Exports over Imports . .	—	—	738*	—	—	—	—	—	—	4,094

* Weights have been converted from gallons and are, therefore, approximate.
(c) Includes Cinnamon, Clove, Mace, Peppermint and Sandalwood Oils.

	1953		1954		1955		1956		1957	
	lb.	£	*lb.*	£	*lb.*	£	*lb.*	£	*lb.*	£
MEDITERRANEAN										
Cyprus										
Almond Oil . .	5,824	1,067	—	—	—	—	1,792	600	—	—
Aniseed Oil . .	112	60	224	270	—	—	—	—	(c)	(c)
Citrus Oil . . .	32,928	33,921	6,720	7,143	11,648	13,334	21,280	29,839	6,496	11,621
Origanum Oil . .	—	—	672	345	3,808	2,076	—	—	(c)	(c)
Other Essential Oils .	336	284	2,912	1,798	(c)	1,478	224	224	(c)	(c)

(c) Information not available.

DOMESTIC EXPORTS OF ESSENTIAL OILS FROM THE COMMONWEALTH COUNTRIES FOR THE YEARS 1953-57†

	1953		1954		1955		1956		1957	
	lb.	£	*lb.*	£	*lb.*	£	*lb.*	£	*lb.*	£
AUSTRALIA (1)										
Eucalyptus Oil	721,330	172,226	504,628	131,010	443,933	122,858	683,131	219,230	547,435	158,858
Patchouli Oil	(2)		(2)		(2)		(2)		(2)	
Sandalwood Oil	—	—	3,057	5,986	(2)		(2)		(2)	
Other Essential Oils	37,614	29,286	80,685	23,283	46,826	36,628	88,667	68,932	58,169	41,729
CANADA										
Essential Oil	18,148	22,200	35,306	34,080	39,855	33,776	70,718	53,389	78,136	68,871
CEYLON										
Cinnamon Bark Oil	921	6,020	979	7,597	1,941	17,922	2,574	23,706	2,429	24,633
Cinnamon Leaf Oil	90,653	33,729	155,314	68,751	87,287	48,121	137,966	42,345	69,925	37,719
Citronella Oil	1,409,315	208,090	1,390,020	349,046	1,576,490	506,264	1,332,144	383,105	1,325,171	312,095
Other Essential Oils	—	—	—	—	—	—	—	—	50	611
INDIA (3)							(April-December)			
Sandalwood Oil	130,458	377,591	153,616	429,961	186,457	541,576	147,529	531,053		
Lemongrass Oil	839,569	293,783	1,247,106	404,107	1,732,882	995,047	1,672,573	839,413	(c)	(c)
Palmarosa Oil	139,421	156,271	97,467	98,028	150,208	210,238	100,550	163,961		
Other Essential Oils	43,961	15,885	103,730	18,249	34,175	9,784	42,687	22,975		

† For earlier statistics see *Colonial Plant and Animal Products*, 1952-3, **3**, 32; 1954, **4**, 28; 1955, **5**, 216. In a few cases the figures previously published have been revised in the light of more recent information.

(1) Years ended June 30th of that stated.
(2) Included, if any, with "Other Essential Oils".
(3) Years ended March 31st until 1955; 9 months April-December, 1956.
(c) Information not available.

Notes

Utilization of Spent Tan Bark.—The economic utilization of spent bark is a problem inherent wherever tannin extraction plants exist. Although waste disposal problems are almost non-existent in the United Kingdom, where practically all the tannin extract is imported, other countries using bark in tanneries or manufacturing extracts are constantly seeking further outlets for their spent product.

The disposal or economic use of spent bark as a by-product from tannery or extract plant wastes is a very old problem and one not easily solved. Compared with the cleaner spent tan bark from the extract factory, the slimy refuse from the tannery presents many disadvantages from the reclamation point of view, and its uses are, therefore, correspondingly restricted. Many factors, such as the type of bark used or the types and proportions of different barks used in a mixture, the quantity of material available, facilities for drying or other processing, labour and transport costs and the consumer demand are involved in assessing the possibilities of an economic use of spent tan bark as a by-product. In view of the limited demand for this type of material, suitable outlets are, therefore, difficult to find.

The loose, fibrous nature of dried spent tan bark, coupled with its ability to absorb about double its weight of liquid, has led to its being used in place of straw, or mixed with straw, for litter or bedding. In this connection, it has been used in circus rings, on race and running tracks, as bedding for livestock and as litter for poultry. The income from these uses, however, is often barely sufficient to cover transport costs.

Spent bark may also be considered as material capable of furnishing the soil with organic matter but not as a true fertilizer. The residual tannin which it may contain when fresh is injurious to vegetation; preliminary fermentation is therefore necessary to destroy the tannin and reduce the bark to humus. The action of the tannin can be neutralized by mixing the spent bark with farm manure, liquid manure or urine, all of which contain ammonia. The spent bark can also be treated with lime and a little slaughter-house blood and allowed to ferment for about eighteen months. Alternatively, the spent bark may be watered two or three times with a solution of iron sulphate with thorough mixing; it is then made to absorb faeces and, after a few months, the manure is fit for use. Spent tan bark has also been used as a fertilizer in combination with phosphates and ashes. The value of the ash of spent wattle and of mangrove bark as a fertilizer has been investigated[1,2] and, in view of the high lime content of these ashes they may profitably be used instead of ground limestone.

After standing for about a year, spent bark (humus) can be either applied direct to grassland or, in horticulture, mixed with the soil, where it retards drying. It may also be used as a protective covering for seedlings or as bedding for transplants (e.g., strawberries) and for hot beds. When saturated with urine and mixed with fresh dung pellets, spent bark has been used for growing mushrooms.

The best quality white lead is still produced by the Dutch or "stack" process and so long as white lead pigment continues to be manufactured in this way there will always be a certain demand for spent bark, particularly for the cleaner material from the extract factory. A British patent[3] describes a combined method of using spent tan bark for the manufacture of fertilizers and white lead. The bark is placed in a pit and treated with organic compounds which should contain potassium, nitrogen, and phosphorus, to support bacterial life. Air is excluded to promote the growth of anaerobic bacteria and after a certain period the treated bark may be used in the "stack" process for white lead manufacture before being sold as fertilizer.

Attempts to use spent tan bark for the manufacture of paper have seldom proved satisfactory or economic, owing to the short length of the fibres, the presence of cork and residual tannin and the availability of more suitable raw

materials. A sample of spent mangrove bark from North Borneo was examined by the Institute (then the Colonial Products Advisory Bureau)[4] and it was considered that the high ash content and alkali solubility, combined with the low cellulose content and very short fibre length, would render the material quite uneconomic for the manufacture of paper pulp. There may, however, be some limited use for certain types of spent bark in the manufacture of fibre and cement boards. A Russian patent[5] describes the use of spent tanning wood as a building material. The spent wood is mixed with husks or other vegetable albuminous products as binder, and alkali or acid is added; the mass is then pressed and dried at ordinary temperature.

Perhaps the method most commonly used to dispose of spent bark, particularly by the big extract manufacturers, is to use the material as a fuel or fuel supplement. In general, however, spent tan barks tend to have calorific values appreciably lower than that of dry wood fuel and, owing to their finely divided state, they are more difficult to burn—factors which detract from their value as fuel. The bark may, therefore, be pressed into "bark cakes" or simply mixed with coal slack before being fed to boilers. However, when spent tan is used for raising steam, it is best to use a special type of destructor and to gasify the material rather than burn it on the grate of an ordinary Lancashire or water-tube boiler. A special type of furnace has been developed for burning spent tan at the rate of 40 cwt. an hour, and when used in conjunction with a Stirling water-tube boiler this furnace will evaporate 1 lb. of water per pound of partially dried bark.

Finally, some mention may be made of the use of spent tan bark as a source of cellulose. In 1939, a report[6] was made on the manufacture of nitro-cellulose from wattle bark in South Africa. The nitro-cellulose had been made in Natal from pure cellulose extracted from waste wattle bark and used as an explosive. In 1942, reports[7,8] were made of a process in which spent tan bark was used for the manufacture of plastics. The waste bark or wood was converted into a good, fast-burning nitrated cellulose simply by treating it with a half-and-half mixture of sulphuric and nitric acids, and afterwards giving the product a thorough washing. No further reference to either of these processes can be traced in the literature and it is probable that they eventually proved uneconomic and were discontinued.

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(1) "South African Tanning Materials". By C. O. Williams. Department of Agriculture, Union of South Africa, Science Bulletin No. 63, Pretoria, 1928, 63.
(2) *Colon. Pl. Anim. Prod.*, 1952-3, **3**, 234-235.
(3) British Patent, 211,322.
(4) *Colon. Pl. Anim. Prod.*, 1952-3, **3**, 53-55.
(5) Russian Patent 35994, April 30th, 1934.
(6) *Chem. Age, Lond.*, 1939, **41**, 85.
(7) ibid., 1942, **47**, 287.
(8) *Oil Paint Drug Reptr.*, 1942, **142**, No. 6, 35.

R.D.C.

Wild Yams from Jamaica.—Two samples of wild yams were received from the Ministry of Agriculture and Lands, Jamaica, for analysis for sapogenin content as part of a scheme for the examination of West Indian yams as sources of diosgenin.

Description.—The samples consisted of approximately 2 lb. each of the partly dried tubers of (1) *Rajania cordata* and (2) *Dioscorea polygonoides*.

Examination.—Each sample was dried at 40°C. and ground to a fine powder. A portion of each sample was examined on a semi-micro scale for the presence of saponins by the chemical method described by Wall, Eddy, McClennan and Klumpp, *Analyt. Chem.*, 1952, **24**, 1337.

(1) *Rajania cordata* gave a negative result.

(2) *Dioscorea polygonoides* gave a positive result and infra-red spectroscopic examination of the sapogenin acetate obtained by the above method indicated the presence of a sapogenin similar to diosgenin. Absorption bands were present at 855, 890, 910, 957 and 975 cm.$^{-1}$. The absorption at 890 cm.$^{-1}$ was stronger

than that at 910 cm.$^{-1}$ indicating that the sapogenin had the *iso*-configuration. The spectrum of a reference specimen of diosgenin acetate exhibited absorption bands at 857, 890, 910, 957 and 975 cm.$^{-1}$.

The saponin was isolated from the remainder of the sample by the method of Wall, Krider, Rothman and Eddy, *J. biol. Chem.*, 1952, **198,** 533. By means of chromatography on an alumina column it was found that only mono-hydroxy, non-ketonic sapogenins were present.

The separated material was acetylated and its acetate recrystallized until the melting point was constant at 194-196°C. Diosgenin acetate was similarly recrystallized and gave a melting point of 195-196°C. The melting point of the mixed acetates was 195-196°C. The melting point of diosgenin acetate is variously quoted in the literature as:

190°C. Fujii and Matsukawa, *J. pharm. Soc. Japan*, 1936, **56,** 408.

195-198°C. Marker, Tsukamoto and Turner, *J. Amer. chem. Soc.*, 1940, **62,** 2525.

196-198°C. Tsukamoto, Ueno and Ohta, *J. pharm. Soc. Japan*, 1936, **56,** 135.

200-202°C. Marker, Wagner, Ulshafer, Wittbecker, Goldsmith and Ruef, *J. Amer. chem. Soc.*, 1947, **69,** 2167.

The yield of diosgenin was 0·2 per cent. calculated on the dry weight of the tuber.

Conclusions.—No positive indication of the presence of saponins was found in the sample of *Rajania cordata* tubers.

The tubers of *Dioscorea polygonoides* contained a saponin which, on hydrolysis, gave diosgenin, the yield being 0·2 per cent. calculated on the dry weight of the tubers.

Wall and co-workers obtained no sapogenins from a sample of *D. polygonoides* from Puerto Rico (*U.S. Department of Agriculture, Agricultural Research Service Circular AIC*-363, 1954), but the same workers report a yield of 0·25 per cent. diosgenin from a sample of *D. polygonoides* tubers from Honduras (*J. Amer. pharm. Ass., Sci. Ed.*, 1957, **46,** 653). This latter result is very near that obtained from the present sample of *D. polygonoides* from Jamaica, and is almost certainly too low for the yams to be of commercial value as a source of diosgenin. Even a content of 1 per cent. would scarcely be of interest, as it is understood that some of the Mexican yams now being exploited as sources of steroidal sapogenins may contain between 2 and 5 per cent. of these substances.

J.A.D.

Pulping Trials on *Pinus caribaea* wood from British Honduras

By A. E. CHITTENDEN and E. R. PALMER

INTRODUCTION

A NUMBER of reports of pulping trials have appeared elsewhere on timber which has been variously named "slash pine", "southern pine" or *Pinus caribaea*, and consequently it would appear at first sight, that this article is not contributing anything new to the literature. However, the timber on which these other trials were carried out was either grown in the southern United States or grown elsewhere from seed obtained from that area. Also, it is felt that quite often the assumption has been made that the closely related species *P. caribaea* and *P. elliottii* are identical both botanically and in timber properties.

The botanical relationship between these two species is made clear in the following extract from a memorandum received by the Tropical Products Institute on the subject from the Royal Botanic Gardens, Kew:

"The present position regarding the nomenclature of *Pinus caribaea* and its relatives is as follows:

Little & Dorman in *J. For. Washington*, **50,** 1952, 918-923, recognize two species—

Pinus caribaea Morelet

Range: West Indies and Central America. Bahama Islands (6 or more, namely, Grand or Great Bahama Is., Great Abaco Is., New Providence Is., and Andros Is., at north-eastern end; North Caicos Is. and Pine Cay in Caicos Is. at south-eastern end; absent from most of Bahama Is.), W. Cuba, in Province of Pinar del Rio, Isle of Pines. Atlantic slope of central America in British Honduras, eastern Guatemala, northern Honduras, and north-eastern Nicaragua. Perhaps also in south-eastern Quintana Roo, Mexico.

P. hondurensis Loock is regarded as a synonym of *P. caribaea* Morelet, as well as a homonym and perhaps also a synonym of *P. hondurensis* Sénéclauze.

Pinus elliottii Engelm. is resurrected as the name for the Slash Pine of the south-eastern United States. Two varieties are distinguished:

var. *elliottii* (typical Slash Pine), ranging along the warm temperate coastal plain from S. Carolina to central Florida and eastern Louisiana; and var. *densa* Little & Dorman, var. -nov., in subtropical Florida and the coasts of central Florida.

According to these authors, var. *densa* has very hard wood with thick summerwood, and is not worked for naval stores products.

A small-coned race of *Pinus caribaea*, found at Pine Cay, Caicos Islands, is mentioned but not given a scientific name."

It is hoped that this report on comparative pulping trials on botanically authenticated samples of the two species will add to the literature on the subject, by indicating that there may also be differences in the timber properties of the two species. Future work by this Institute and by other workers will no doubt enable a better assessment of these differences to be made.

Description

The original samples of *P. caribaea* were accompanied by botanical material which was submitted to the Royal Botanic Gardens, Kew, and identified as belonging to *P. caribaea* Morelet. No details regarding age of the timber or length of storage time after felling were given for these original samples. Additional samples from freshly felled *P. caribaea* timber from different age groups were asked for and sent from British Honduras January, 1957, and consisted of one half disc and five whole discs of timber as follows:

Original Samples

These arrived at the Colonial Products Laboratory, now the Tropical Products Institute, by surface transport in October 1955 and consisted of two de-barked logs as follows:

	Log No. 6	*Log No.* 7
Dimensions:	10 in. by 10 in. by 52 in.	10 in. by 10 in. by 48 in.
Weight:	129 lb.	108 lb.

These logs seemed to be very old, dense and resinous, but were, nevertheless, quite sound.

Additional Samples

These arrived at the Colonial Products Laboratory by air on the 18th January, 1957, and consisted of one half disc and five whole discs of timber as follows:

No. 1 Half disc, $7\frac{1}{2}$ in. × 4 in. × $1\frac{1}{2}$ in.
Weight: 490 g.
Measured at breast height.
Tree 24 years old. Natural Pine encouraged by fire.

No. 2 Disc, $6\frac{1}{2}$ in. × $6\frac{1}{2}$ in. × 1 in.
Weight: 426 g.
Measured at breast height.
Tree 17 years old. Natural regeneration of burnt area.

No. 3 Disc, 6 in. × 6½ in. × 1 in.
Weight: 454 g.
Measured at breast height.
Tree 12 years old. Plantation grown.

No. 4 Disc, 5½ in. × 6 in. × 1 in.
Weight: 374 g.
Measured at breast height.
Tree 13 years old. Plantation grown.

No. 5 Disc, 5½ in. × 5½ in. × 1½ in.
Weight: 479 g.
Measured at breast height.
Tree 10 years old. Plantation grown

No. 6 Disc, 3½ in. × 3½ in. × 1½ in.
Weight: 211 g.
Measured at breast height.
Tree 11 years old. Plantation grown.

Note.—The first two dimensions represent in each case the diameters measured in two directions at right angles to each other.

These samples were very fresh, having been felled in British Honduras on the 4th-5th January, 1957. They had been de-barked and were in very good condition. It should be noted here that there is little correlation between the diameter of the discs and the age of the tree from which they were obtained.

The original samples had been stored in a dry, ventilated outside store at the Colonial Products Laboratory until required for examination. The additional samples were examined immediately after receipt. The original two log samples were treated as one sample for the purpose of the present investigation and, to avoid repetition, it is designated "Sample A" in this report. The additional samples are given the same numbers as those shown in the description above.

As the examination proceeded it was considered that it would be useful to have a sample of *Pinus elliottii* timber (the "slash pine" of the Southern U.S.A.) for comparison purposes. A 12-year-old sample of *P. elliottii* was kindly supplied to the Laboratory for this purpose by the Forest Service of the U.S. Department of Agriculture (Southeastern Forest Experimental Station).

This sample consisted of a piece of timber, with bark attached, about 1½ in. in diameter, 2 ft. 2 in. long and weighing about 3 lb. The timber was in good condition and appeared to have been freshly felled. A count of the annual rings indicated that the timber was about 12 years old.

Sampling

Since both logs comprising sample A had similar external appearances, one log (No. 6) was chosen and sawn into billets of 4 in. square section

which were converted into chips in a two-knife disc chipper. These chips were used for all subsequent work on this sample. Samples 1-6 (the fresh samples) and the sample of *P. elliottii* were too small to be chipped in the disc chipper. Consequently, chips of approximately the same size as the machine chips were cut from each of these discs by hand. There was only sufficient material from these samples for small pulping trials and the microscopical examination.

Chemical Examination

A chemical analysis of the air-dry ground chips yielded the following results:

Chemical Analysis (Sample A)

	Per cent.
Moisture	7·7
Expressed on moisture-free material:	
Holocellulose	58·4
α-cellulose	39·3
Alcohol-benzene extractives	1·6
Ash	0·37
Pentosans	8·9

Notes:

(1) Holocellulose by method of Wise, Murphy and D'Addieco (*Paper Trade J.*, 1946, **122,** No. 2, 35).

(2) Other chemical analyses were carried out according to the respective standard methods of the American Technical Association of the Pulp and Paper Industry.

Microscopy of Ultimate Fibres

Ultimate fibres were prepared from each sample by the sodium chlorite maceration method (W. E. Spearin and I. A. Isenberg, *Science*, 1947, **105,** No. 2721, 214).

The dimensions of these ultimate fibres were measured by the projection microscope and the results are given in Table I. It is appreciated that, strictly speaking, the correct botanical term for the fibrous cells of a conifer is "tracheids" not "fibres". The term fibre has, however, become so firmly established in the pulp and paper industry as referring to all fibrous materials that it has been used throughout this report.

Despite every possible precaution it was found to be impossible to produce batches of ultimate fibres from all the samples, except *P. elliottii*, which did not contain a considerable proportion of broken fibres. Eventually, a standardized method of treatment was designed so that each batch was subjected to the same minimum chemical and physical treatment. Even so, the number of broken fibres present in all the material made accurate measurement of the fibre length impossible. By observation, however, it was apparent that *P. caribaea* has an ultimate fibre length of about 5 mm. The production of ultimates from the *P. elliotti* timber presented no difficulty and a subsequent examination showed that only a negligible number of fibres was broken. Consequently, it was possible to measure the length of these fibres, and it was found that their mean fibre length was 2·58 ± 0·7 mm. giving a calculated length range of 1·18–3·98 mm.

Table I shows that there is little correlation between the age of the timber and either the "coefficient of suppleness" or the number of broken fibres present. It must be pointed out, however, that Sample A was so dry when chipped that the large proportion of broken fibres obtained when the chips were reduced to ultimate fibres is probably due to mechanical chipper damage. There seems no doubt, however, that *P. caribaea* fibres are quite brittle, a very mild physical treatment being sufficient to break a great many of them.

Table I also shows that the diameter of the fibre and that of the lumen tend to decrease with the increasing age of the tree. The correlation is not good, which indicates that some other factor is influencing the fibre dimensions. Further evidence for the existence of this factor, probably the rate of growth, is provided by the fact that the diameter of the tree in Samples 1-6 is not proportional to the age. Also, Sample A can be assigned to a different age in comparison with Samples 1-6 according to the particular physical property used in the comparison.

The measurements obtained for *P. elliottii* indicate that the fibres of this timber have quite different characteristics from those of *P. caribaea*. They are, in fact, shorter and thinner fibres but have the same order of fibre wall thickness.

Pulping Trials

Pulping trials were carried out by the sulphate process and consisted of two main parts: (a) pilot cooks carried out in a small stationary electrically heated digester of about 1½ litres capacity and (b) larger cooks carried out in a rotating electrically heated digester of about 15 litres capacity. Part (a) cooks (with a "P2K" serial number) were done on Samples A, 1, 3, 5 and 6 and *P. elliottii* in an attempt to elucidate the effect of timber age on pulping characteristics. These small cooks were necessary in view of the small size of the samples other than Sample A. Part (b) cooks (with a K serial number) were done on Sample A only in order to produce sufficient pulp for the evaluation of beating effect. It must be emphasized that, due to various factors, comparison between a pilot "P2K" cook and a larger "K" cook under the same conditions on the same sample is not possible.

Table II shows the comparison between the unbleached pulp yields obtained from pilot cooks on these samples when subjected to the same digestion conditions. There is no correlation between the known age of timber and yield. However, these figures are based on single determinations and, assuming that Sample A is, as it appeared, very old, there is the expected indication of a lower yield from the younger timber. *P. caribaea* and *P. elliottii* timbers of the same age gave very similar results for yield and alkali consumption.

Table III gives the data on the two larger cooks on Sample A and shows that the conditions of K42 give the highest screened yield of pulp with the lowest alkali consumption. The shorter cooking time required in comparison with the pilot cooks is due to the effect of a rotating digester. This cook (K42) was used for the evaluation of beating effect. The physical appearance of the pulp produced from all samples, except

P. elliottii, is worthy of comment. The individual fibres of the pulp possessed an unusual sheen and the pulp had something of the appearance and feel of glass wool. The *P. elliottii* pulp appeared perfectly normal in all respects.

Pulp Evaluation and Beating Effect

Part (a) Pilot Cooks

Attempts were made to make Standard Sheets from the pulp from each cook by means of the British Standard Sheet Machine, in order to evaluate the paper-making properties of these pulps. The method used was that described in the Second Report of the Pulp Evaluation Committee of the Paper Makers' Association. It became immediately obvious that it was impossible to produce Standard Sheets strictly according to the Official Method from any unbeaten pulps made from *P. caribaea*. As will be seen, it was also impossible to make Standard Sheets from some of the beaten pulps. As a compromise, some modifications of the Standard Method were made (details are given below the appropriate tables), but these modifications could not be standardized and consequently results from these tests are of limited value for comparison purposes. In the tables given in this report, these non-standard pulp evaluation results are marked with an asterisk. No such difficulties were experienced with the *P. elliottii* pulp.

In view of this difficulty, it was decided to evaluate the pulps from these pilot cooks by means of sheets produced from beaten pulp. Because of the small quantities of pulp available, they were beaten in the Lampen Ball Mill Beater according to the Tentative Method of the Evaluation of the Beating Effect described in the Second Report to which reference has already been made.

The results of these beating trials are given in Tables IV and V. It will be seen that with *P. caribaea* there was a tendency for cooks from the younger timber samples to produce slightly stronger and freer pulps.

Tables IV and V also show the results obtained with the Lampen Mill on pulps from the pilot cooks of *P. caribaea* and *P. elliottii* in comparison with figures given for Lampen beaten "slash pine" pulp by Hebbs. (*Proc. Tech. Sect. B.P. & B.M.A.*, **33,** Pt. 2, 300.) This "slash pine" pulp is apparently from the southern United States and is therefore, presumably, also from the timber of *P. elliottii*. No details are given of the cooking conditions required to produce this "slash pine" pulp, but it is felt that these results can be compared with the other pulps in Tables IV and V beaten to a similar freeness figure. It will be seen that the *P. caribaea* pulp is inferior in many respects (burst, tensile strength and tear) to the *P. elliottii* pulp of equal freeness produced at the Tropical Products Institute from timber of the same age.

Part (b) Larger Cooks

The purpose of these trials was to try and evaluate sulphate pulp from Sample A (K42) *P. caribaea* over a complete beating range in comparison with other well-known pulps. These results are given in Tables VI, VII and VIII.

Table VI shows that in the Lampen Beater the strength of *P. caribaea* pulp begins to level off at a beating time of between 50 and 60 minutes, and that, in fact, the tear and fold have already begun to fall. In Table VII (Valley Beater) the tear has begun to fall at the 120 minute beat, although the other strength characteristics are still rising. The high drainage time (low freeness) of the long beaten pulps is, however, increasing out of all proportion to any increase in strength.

Tables VII and VIII show, by direct comparison, the differences between K42 Sample A pulp and a commercial sample of unbleached Scandinavian kraft pulp both beaten in a 1½ lb. Valley Niagara Beater with 5·5 kg. on the bedplate. In many respects (e.g., burst, tensile strength and fold) the two pulps are very similar, but the *P. caribaea* pulp requires considerably longer beating time to develop an equivalent strength. The tear of *P. caribaea* pulp is markedly superior to the commercial kraft pulp, but the freeness at equivalent beating times is very much lower.

The results in Tables VI, VII and VIII are illustrated graphically on the beating curves which accompany this report.

Conclusions

1. There are a number of restrictions which must, unfortunately, be placed on the scope of the conclusions drawn from this report on *P. caribaea* timber. These are:

(a) No details of age, etc., are available for the large original Sample A which was used for the bulk of the pulp evaluation work.

(b) This Sample A was so dry when chipped that some of the results of work carried out on it may be affected by the inevitable broken fibre present.

(c) The fresh samples and the sample of *P. elliottii* were too small for anything but small scale, rather incomplete pulping trials.

(d) The difficulties in the production of Standard Sheets from many of the *P. caribaea* pulps. This difficulty in Standard Sheet production from exotic conifers has also been recently reported by Istas for *P. occidentalis* (syn. *P. cubensis*) from the Belgian Congo (*Publications de L'Institut National pour L'Etude Agronomique du Congo Belge*, 1956, Série Technique No. 51, p. 135), and by von Koeppen for *Araucaria klinkii* (Klinki Pine) from New Guinea (*C.S.I.R.O. Div. of Forest Products, Australia, Project PP.*17, *Sub Project PP.*17-2, Progress Report No. 1, Sept. 1956).

Despite these unavoidable shortcomings it is considered that some useful data about the pulping properties of *P. caribaea* have been obtained and some valid conclusions can be drawn.

2. From the results of the microscopical examinations, it appears that the fibres of *P. caribaea* are rather brittle and easily broken by mild physical treatment. This examination, together with the results obtained by the pilot cooks, indicates that the age of the timber and other factors (probably rate of growth and/or environment) tend to influence the fibre characteristics (and hence the pulp quality) of *P. caribaea*. These effects are already well known for conifers in general and have been repeatedly reported in the past, but a great deal more work will be required before

the precise extent of these variations on *P. caribaea* are completely known.

3. Although *P. caribaea* is now recognized as a different species from the "slash pine" (*P. elliottii*) of the southern United States, both species are still frequently referred to by the same vernacular name "slash pine". This investigation has shown that almost certainly there is a difference between sulphate pulps produced from the two species.

4. Most exotic conifers have always been known to give pulps of high tear in comparison with their temperate counterparts and *P. caribaea* is no exception to this rule. The long beating times required to produce sheets of good strength, with the accompanying low freeness values, seem to be a very undesirable feature of *P. caribaea* pulp. It is possible, however, that some of this effect may be due to the tendency of the fibres to break up as referred to in (2) above.

Acknowledgements

The authors would like to acknowledge the assistance received from the U.S. Department of Agriculture (Southeastern Forest Experimental Station) in providing an authenticated sample of *P. elliottii* and from Monsieur J. R. Istas of the Laboratoire de Recherches Chimiques du Ministère des Colonies, Tervuren, Belgium, for providing unpublished information on the practical difficulties encountered in making Standard Sheets from other exotic pine pulps from the Belgian Congo.

TABLE I

Microscopical Examination of Fibres

	Pinus caribaea							*P. elliottii*
Sample Number . .	A	1	2	3	4	5	6	U.S.A. (1)
Age, *years* . . .	Not known	24	17	12	13	10	11	12
Mean Fibre Diameter, *microns* . . .	39·30±0·94	42·48±1·01	42·44±1·02	47·28±1·20	47·34±1·42	50·06±1·22	50·54±1·36	28·5 ± 0·61
Calculated Range of Fibre Diameter, *microns* (2) .	37·42–41·18	40·46–44·50	40·40–44·48	44·88–49·68	44·50–50·18	47·62–52·50	47·82–53·26	27·28–29·72
Mean Fibre Wall Thickness, *microns* . . .	7·32±0·36	11·96±0·24	9·40±0·38	8·00±0·34	7·04±0·24	7·04±0·28	9·08±0·34	7·6± 0·53
Calculated Range of Fibre Wall Thickness, *microns* (2)	6·60 – 8·04	11·48–12·44	8·64–10·16	7·32 – 8·68	6·56 – 7·52	6·48 – 7·60	8·40 – 9·76	6·54 – 8·66
Mean Lumen Diameter, *microns* (Calculated) .	24·66	18·56	23·64	31·28	33·26	35·98	32·38	13·3
"Coefficient of Suppleness" (Calculated) (3) . .	63	44	56	66	70	72	64	47
Fibres Broken, *per cent.* (4)	82	60	68	50	66	50	56	negligible

(1) Sample of authenticated *P. elliottii* received from the U.S. Department of Agriculture (Southeastern Forest Experimental Station).

(2) Calculated Range = 95 per cent. calculated limits.
Based on Mean ±2 × Standard Deviation which is shown after the mean in each case.

(3) "Coefficient of Suppleness" $= \frac{\text{Diameter of Lumen} \times 100}{\text{Diameter of Fibre}}$

(4) Fibre length was not measured due to the large proportion of broken fibres.

TABLE II

Sulphate Pilot Cooks. Digestion Data

Cook Number	P2K14	P2K17	P2K16	P2K19	P2K18	P2K20
			Pinus caribaea			*P. elliottii*
Sample Number	A	1	3	6	5	
Age of Tree, *years*	Not Known	24	12	11	10	12
Effective Alkali as NaOH on oven dry raw material, *per cent.* (1)	20	20	20	20	20	20
Sulphidity, *per cent.* (2)	30	30	30	30	30	30
Liquor to oven dry raw material ratio	6 : 1	6 : 1	6 : 1	6 : 1	6 : 1	6 : 1
Maximum Temperature, °C.	170	170	170	170	170	170
Time to reach maximum temperature, *hours*	1	1	1	1	1	1
Time at maximum temperature, *hours*	5	5	5	5	5	5
Consumption of Effective Alkali on oven dry raw material	17·1	17·3	16·7	15·7	15·8	17·1
Yield of Unbleached Pulp — Screened pulp, *per cent.*	51·7	44·8	47·3	41·7	44·2	49·3
Yield of Unbleached Pulp — Screenings, *per cent.*	1·3	2·7	2·0	1·4	3·3	0·7
Yield of Unbleached Pulp — Total, *per cent.*	53·0	47·5	49·3	43·1	47·5	50·0

(1) Effective Alkali = $NaOH + \frac{1}{2} Na_2S$ expressed as NaOH.

(2) Sulphidity $= \dfrac{Na_2S \times 100}{Na_2S + NaOH}$ Sodium compounds expressed as NaOH.

TABLE III

Pinus caribaea (*Sample A*). *Sulphate Cooks. Digestion Data*

Sample Number		A	
Cook Number		K42	K43
Effective Alkali as NaOH on oven dry raw material, *per cent.* (1)		20	18
Sulphidity, *per cent.* (2)		30	25
Liquor to oven dry raw material ratio		6 : 1	6 : 1
Maximum Temperature, °C.		170	170
Time to reach maximum temperature, *hours*		1	1
Time at maximum temperature, *hours*		3	3
Consumption of Effective Alkali on oven dry raw material		12·6	13·1
Yield of Unbleached Pulp	Screened Pulp, *per cent.*	49·0	33·4
	Screenings, *per cent.*	6·0	21·9
	Total, *per cent.*	55·0	55·3

(1) Effective Alkali = NaOH + $\frac{1}{2}$ Na_2S expressed as NaOH.

(2) Sulphidity $= \dfrac{Na_2S \times 100}{Na_2S + NaOH}$ Sodium compounds expressed as NaOH.

TABLE IV

Sulphate Pilot Cooks. Unbleached, Beaten Pulp Evaluation

Comparison of Age and Beating Effect in P. caribaea

Lampen Beater

Cook Number	P2K14			P2K17		P2K16			P2K19		P2K18	
Sample Number	A			1		3			6		5	
Age of Tree, *years*	Not Known			24		12			11		10	
Beating Time, *min.*	30*	40*	50*	30*	40*	30*	40*	50*	30	40	30	40
Basis Weight, *g./sq. metre*	59·6	61·4	59·3	63·0	58·2	68·6	62·0	60·7	58·5	62·2	62·2	62·4
Thickness, *microns*	101	95	88	98	89	95	101	91	96	98	97	97
Bulk	1·69	1·55	1·48	1·56	1·53	1·38	1·63	1·50	1·64	1·58	1·56	1·55
Burst Factor	36·2	40·3	39·5	45·9	52·2	29·0	36·1	32·0	48·5	52·9	51·4	52·2
Breaking Length, *metres*	5950	6539	6754	6892	8166	4426	5634	5366	7488	7977	7918	8055
Stretch, *per cent.*	4·5	4·4	4·1	4·5	4·9	4·9	4·9	4·1	4·4	4·5	4·5	4·3
Tear Factor	191	171	152	231	175	157	169	129	205	178	198	173
Double Folds, Kohler-Molin, 600 *g.*	2159	3948	2614	4444	4682	1178	2035	715	3811	4030	4625	4507
Drainage Time, *sec.*	4·7	6·1	8·1	5·0	8·7	4·8	4·4	5·4	4·4	4·7	4·9	5·0
Canadian Standard Freeness	510	230	165	465	230	570	620	280	610	470	530	450

*Not Standard Sheets. Sheets adhered to the wire and not to the couching blotter. Sheets needed to be peeled off the wire and left some fibres on the wire.

TABLE V

Pinus elliottii *and "Slash Pine"*

Sulphate Pilot Cook. Unbleached, Beaten Pulp Evaluation

Lampen Beater

Cook Number	P2K20 (*P. elliottii*) (1)				"Slash Pine" (Hebbs) (2)
Age of Tree, *years*	12				—
Beating Time, *min.*	0	30	40	50	89
Basis Weight, *g./sq. metre*	63·9	58·8	60·5	59·2	—
Thickness, *microns*	135	93	92	87	—
Bulk	2·11	1·58	1·52	1·47	—
Burst Factor	23·2	42·3	40·2	43·2	71·8
Breaking length, *metres*	3986	6423	6378	6672	8540
Stretch, *per cent.*	2·9	4·4	4·6	4·4	—
Tear Factor	149	158	152	139	307 (3)
Double Folds, Kohler-Molin, 600 *g.*	147	1926	1547	1560	—
Drainage Time, *sec.*	4·4	4·6	4·9	5·6	6
Canadian Standard Freeness	700	660	470	320	300

(1) Sample of authenticated *P. elliottii* received from the U.S. Department of Agriculture (Southeastern Forest Experimental Station).

(2) *Proc. Tech. Sect. B.P. & B.M.A.*, **33,** Pt. 2, 300.

(3) This figure is calculated according to the Interim Report of the Technical Section's Pulp Evaluation Committee and should be divided by 2 to compare with the other results which are calculated according to the Second Report of this Committee.

TABLE VI

Pinus caribaea (*Sample A*)

Sulphate Cook. Unbleached, Beaten Pulp Evaluation

Lampen Beater

Cook Number	K42						
Beating Time, *min.*	0*	10*	20*	30*	40*	50*	60*
Basis Weight, *g./sq. metre*	60 (a)	61·7	58·2	57·6	64·9	55·0	61·3
Thickness, *microns*	178	126	115	111	119	94	101
Bulk	2·97	2·04	1·96	1·93	1·83	1·71	1·65
Burst Factor	7·0	19·3	27·7	28·3	28·2	38·4	38·2
Breaking Length, *metres*	1489	3702	4690	4754	4691	5802	5941
Stretch, *per cent.*	2·1	3·8	4·4	4·1	4·6	4·2	4·3
Tear Factor	102	214	206	224	217	215	166
Double Folds, Kohler-Molin, 600 *g.*	5	551	1633	1334	1639	2713	2304
Drainage Time, *sec.*	4·9	4·2	4·4	4·2	4·5	5·4	6·0
Canadian Standard Freeness	745	750	710	690	650	275	240

* Not Standard Sheets. Sheets adhered to the wire and not to the couching blotter. Sheets needed to be peeled off the wire and left some fibres on the wire.

(a) Value for Basis Weight assumed. Insufficient sheets prepared due to couching troubles.

TABLE VII

Pinus caribaea (*Sample A*)

Sulphate Cook. Unbleached, Beaten Pulp Evaluation

Valley Beater

Cook Number					K42			
Beating Time, *min.*	0*	15*	40*	60*	80	100	120
Basis Weight, *g./sq. metre*	60 (a)	60 (a)	60·8	59·6	57·1	59·7	57·6
Thickness, *microns*	178	138	122	110	103	99	96
Bulk	2·97	2·30	2·01	1·85	1·81	1·66	1·66
Burst Factor	7·0	18·3	39·1	44·5	56·7	61·1	63·9
Breaking Length, *metres*	1489	3200	5721	6367	7398	8170	8930
Stretch, *per cent.*	2·1	3·3	5·4	6·4	6·3	6·1	4·8
Tear Factor	102	180	252	254	257	256	240
Double Folds, Kohler-Molin, 600 *g.*	5	258	4647	4624	5415	5457	6716
Drainage Time, *sec.*	4·0	4·4	4·3	5·8	10·2	73	212
Canadian Standard Freeness	745	760	560	340	200	70	30

* Not Standard Sheets. Sheets adhered to the wire and not to the couching blotter. Sheets needed to be peeled off the wire and left some fibres on the wire.

(a) Value for Basis Weight assumed. Insufficient sheets prepared due to couching troubles.

TABLE VIII

Swedish Korsnas Herculite Kraft

Unbleached, Beaten Pulp Evaluation

Valley Beater

Beating Time, *min.*	0	5	10	15	20	25	30
Basis Weight, *g./sq. metre*	61·8	62·6	62·0	58·8	59·8	59·4	61·6
Thickness, *microns*	129	121	114	103	101	100	98
Bulk	2·09	1·93	1·84	1·75	1·69	1·68	1·59
Burst Factor	19·1	32·5	37·9	45·7	51·0	56·9	58·4
Breaking length, *metres*	3107	4808	5611	6748	7252	8229	8383
Stretch, *per cent.*	3·2	4·4	4·0	4·4	4·7	4·0	4·2
Tear Factor	150	178	162	166	149	150	123
Double Folds, Kohler-Molin, 600 *g.*	99	1736	3318	4466	4408	5166	7324
Drainage Time, *sec.*	4·5	4·6	4·7	4·9	4·9	5·1	5·1
Canadian Standard Freeness	680	670	640	630	590	560	510

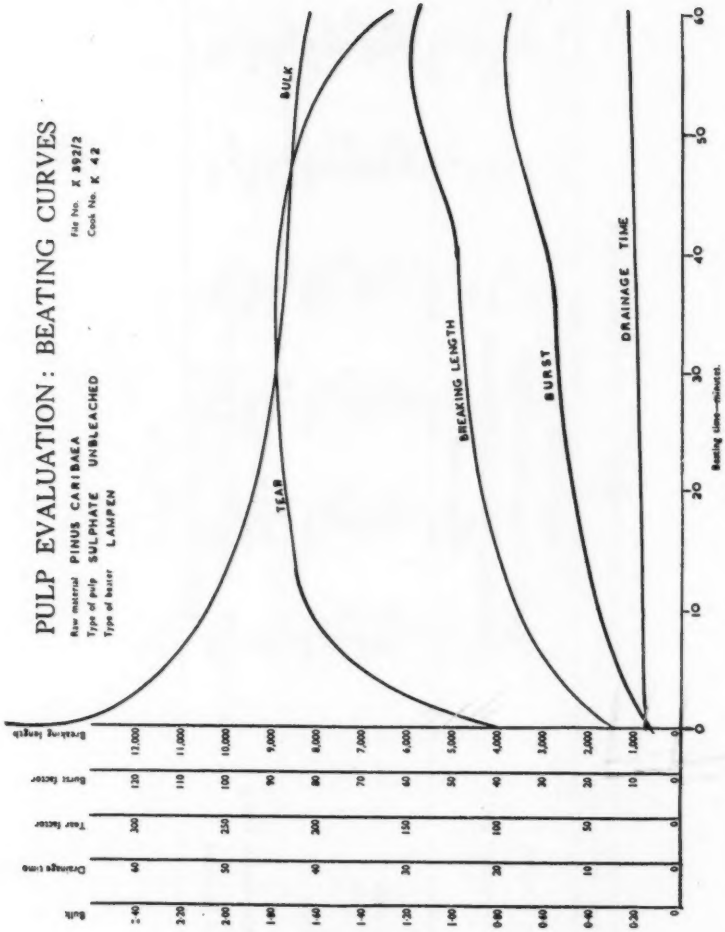
PULP EVALUATION: BEATING CURVES
Raw material PINUS CARIBAEA
Type of pulp SULPHATE UNBLEACHED
Type of beater LAMPEN
File No. X 392/2
Cook No. K 42
BULK
TEAR
BREAKING LENGTH
BURST
DRAINAGE TIME
Beating time—minutes
Bulk
Drainage time
Tear factor
Burst factor
Breaking length

FIG. 1

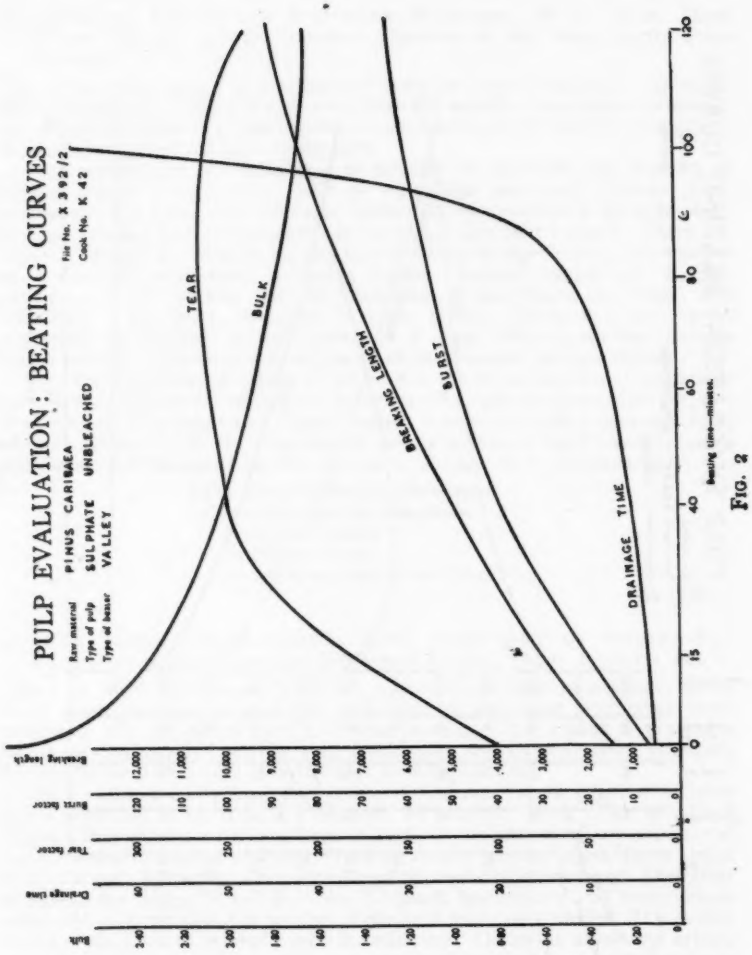
PULP EVALUATION: BEATING CURVES
Raw material PINUS CARIBAEA
Type of pulp SULPHATE UNBLEACHED
Type of beater VALLEY
Test No. X 392/2
Cook No. K 42
TEAR
BULK
BREAKING LENGTH
BURST
DRAINAGE TIME
Beating time—minutes
Breaking length
Burst factor
Tear factor
Drainage time
Bulk

FIG. 2

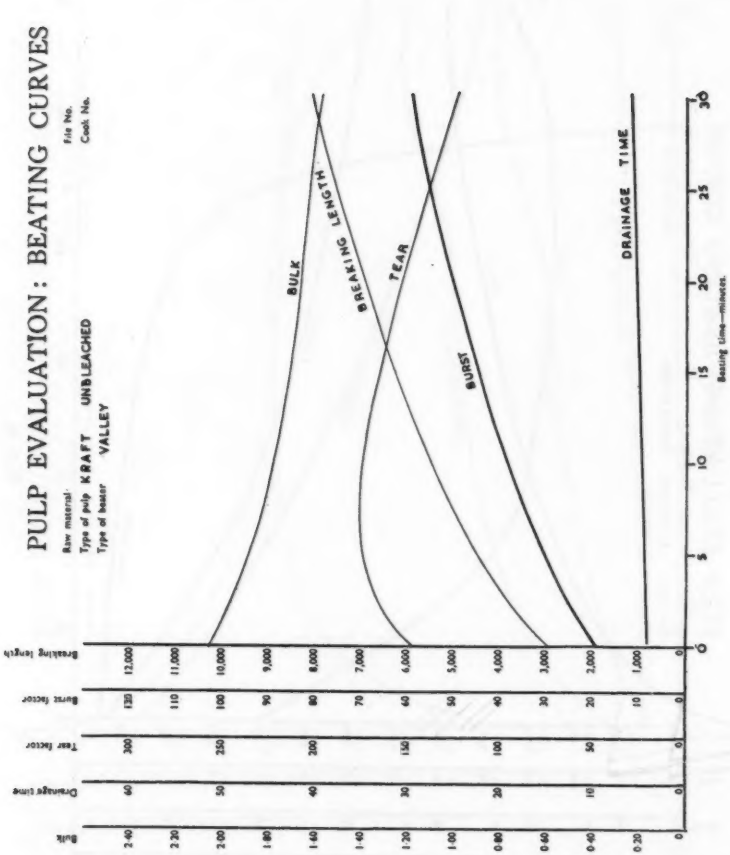
PULP EVALUATION: BEATING CURVES
Raw material:
Type of pulp KRAFT UNBLEACHED
Type of beater VALLEY
File No.
Cook No.
BULK
BREAKING LENGTH
TEAR
BURST
DRAINAGE TIME
Beating time—minutes
Bulk
Drainage time
Tear factor
Burst factor
Breaking length

FIG. 3

Book Reviews

TECHNOLOGY FOR SUGAR REFINERY WORKERS. By O. Lyle. Third Edition. 663 pp., 9 × 6. (London: Chapman & Hall Ltd., 1957). Price 70*s.* net.

This is the third edition of a recognized work on sugar technology. Although written mainly for workers in a refinery, there is a wealth of information presented in a pleasing manner of general interest to anyone concerned with the production of sugar from either the cane or the beet.

The main object of the book is to describe the structure and working of various pieces of equipment, such as centrifugal machines, vacuum pans, evaporators and filters, or to elaborate certain concepts involved in the technology of sugar refining such as electricity, steam power and heat transfer. There are chapters devoted to the planning and interpretation of experiments, and another to commercial information covering history, bonded warehouses, Empire preference, world markets, and the relationship of the wholesaler, retailer and distributor. The work, therefore, includes all the information that could reasonably be required of any worker in a sugar refinery, whether he was concerned with research and development or with commercial operations.

Not the least pleasing aspect of the book is the large selection of quotations from a wide assortment of authors including Chaucer, Diogenes, Cowper and Shakespeare. The chapter on Sugar Analysis commences with a quotation from Milton's *Comus*, "With thy long-levell'd rule of streaming light", and Gilbert's *Bab Ballads* are ransacked for the adornment of Chapter 23 (Commercial):

"You do not often get the chance
Of seeing sugar brokers dance
From their abode
In Fulham Road
Through Brompton to the City."

W.D.R.

LONDON MEAT TRADE ANNUAL AND DIRECTORY OF ANIMAL BY-PRODUCTS 1957. (London: Wheatland Journals Ltd.). Price 21*s.* net.

This Year Book contains, as heretofore, a mass of information especially useful to all those concerned in any way with livestock and meat production, meat processing, and the sale of meat and meat products. It is a book of 311 pages and is divided into five sections, viz.: Associations and Organizations, Directory Section, Meat Associations, Services and Retail Butchers.

Each section is easily located by means of "cut-outs" at the edges of the book and it is possible to ascertain in a moment, for example, which of the new Food Hygiene Regulations came into force in 1956, or the address of any member of the National Association of Poultry Packers, or the location of any Sales Depot of the Fatstock Marketing Corporation and the name of its manager. Operators of Self-Service Stores, Retail Butchers, Livestock Auctioneers, and many others connected with one aspect or another of the meat trade are included. It is clearly a very useful book to be kept handy for reference. Occasions are always arising when the names and addresses of certain people in the trade are required and it is almost certain that these can be found in this book.

L.H.G.-B.

VARNISH MANUFACTURE AND PLANT. By H. W. Chatfield, Ph.D., B.Sc., F.R.I.C., M.I.Chem.E. xxiv + 443 pp., 8¾ × 6. (London: Leonard Hill (Books) Ltd., 1957). Price 45*s.* net.

This is the second edition of that first issued in 1949 and is a companion volume to the author's *Varnish Constituents* which has been through three editions. Its

layout seems very similar to that of the first edition but, in Chapter 4 (on Heat Transfer), methods of induction heating and flexible electrical surface heating call for new headings and, in Chapter 14, new matter concerns the manufacture of alkyd resins by the azeotropic method and by the continuous method of polycondensation. Otherwise the general impression gained by a comparison of this volume with its predecessor is that this is an amended re-issue rather than a thorough revision. This may be a reflection of the small change that has occurred in varnish manufacturing methods in the past decade but, if so, it is in contrast with the revision necessitated in the companion volume on *Varnish Constituents* over about the same period.

For those who are not familiar with *Varnish Manufacture and Plant* there is a discussion on the choice and properties of raw materials for plant construction including materials such as inconel, copper alloys and fused silica. Chapters are devoted to the storage of raw materials and finished products, heat transfer, the transportation of fluids and other unit processes. There are sections dealing with plant accessories such as those devoted to valves and cocks: others are devoted to processes peculiar to the varnish trade (e.g. the manufacture of dehydrated castor oil, of driers and paint removers). The layout of a varnish factory and the legal aspects of varnish manufacture are discussed. The volume thus deals comprehensively with all aspects of modern varnish manufacture.

W.D.R.

INSECT PESTS OF FARM, GARDEN AND ORCHARD. By L. M. Peairs and R. H. Davidson. 5th Edition, viii + 661 pp., 577 figs., 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall Ltd., 1956). Price 68*s*.

The first edition of this book was published in 1912, and this fifth edition has been revised and most of the text rewritten. It is clearly printed, with singularly few typographical errors, on good quality paper, and is generously illustrated with well selected line blocks and photographs.

The insect pests covered are those of importance in the U.S.A., and this necessarily limits the use of the book elsewhere. Nevertheless, it is a very valuable reference book for all economic entomologists. The first seven chapters cover morphology, development, and classification of insects, natural and artificial control, insecticides, formulations, and methods of application. This is undoubtedly the weakest part of the book. A great deal of ground is covered rather superficially, in a style reminiscent of a condescending school master, and a number of statements made are open to question. The classification system used will not meet with the approval of most British entomologists. In the section on insecticides undue space is devoted to some of the older compounds, now of only minor importance, while a number of the major modern synthetics are inadequately covered; for example, arsenic gets one and a quarter and the plant derivatives nearly two pages, though most of the chlorinated hydrocarbon and organo-phosphorus compounds receive only a few lines each. However, in view of the rate at which new insecticides are currently being introduced, this failing is inevitable in any text-book. A compatibility chart, conversion tables and dilution tables are given, though it should be noted that the dilution tables for fluids are calibrated in U.S. and not Imperial gallons.

Chapters 8 to 21 deal with the pests of various crops, and the last two chapters cover insects injurious to stored products, domestic animals, and man. For each pest is given a brief life history, type of damage caused, and control measures that can be applied. This section makes most interesting and informative reading, and adequately compensates for the shortcomings of the opening chapters. As a whole the book is an excellent production which can be strongly recommended.

B.H.H.-W.

PLANT PATHOLOGY. By John Chas. Walker. 2nd Edition, xi + 707 pp., 9¼ × 6½. (London: McGraw-Hill Publishing Co. Ltd., 1957). Price 75*s*.

The purpose of this book is to provide the basic facts necessary to introduce the American student to the scientific foundations of plant pathology. Consequently,

no attempt has been made to include a complete account of all American plant diseases since it is not intended that the text should serve as a work of reference on the subject. Instead, nearly 100 representative diseases of plants have been chosen for detailed consideration, and descriptions have been given regarding their symptoms, causal factors, disease cycles and control. Nevertheless, although the choice of matter for treatment has had to be selective, it is claimed that all major diseases which affect the chief agricultural crops and forest trees of the United States have been included.

Following an introduction to the subject, a discussion of definitions and terms, and the classification of diseases, a chapter on the history of plant pathology is provided, as the author considers that it is necessary to give an account of the development of a science in order that its current trends may be fully understood. Thereafter, in a series of chapters, which form the main part of the book, the diseases included are dealt with in groups according to their causal organisms. Professor Walker places plant diseases into three classes, nonparasitic, parasitic and virus diseases, and the subject matter is treated in this order. The work is concluded by chapters in which the relationship of environment to disease development, host and parasite interactions, and disease control are discussed.

Extensive bibliographies to original literature have been provided throughout the text, which has been illustrated with a large number of excellent photographs, drawings and diagrams. This work should prove to be well suited to its purpose and will no doubt be widely used by American agricultural students of plant pathology. It should also be of service to students of the subject in other countries.

E.H.G.S.

DICTIONNAIRE DES HUILES VÉGÉTALES. By Paul H. Mensier. viii + 763 pp., 10 × 6¾. (Paris: Editions Paul Lechevalier, 12 Rue de Tournon, 1957). Price 10,000 francs.

This work is Vol. 52 of the *Encyclopédie Biologique*. It deals with a vast number of oilseeds, many of which are obscure and little known. Following a brief discussion of the plant, the chief characters of the oilseed are then described and mention made of products other than oil which it yields (e.g., cotton). There is also a description of the oil by-products (e.g., carotene from palm oil). In addition to the usual constants and chemical composition of the oil, the extreme reported values are also recorded.

It is only to be expected that in a work dealing with the vast number of entries found in the present volume omissions can be noticed. Thus, in writing about species of *Balanites* no mention has been made of the possibility of utilizing the saponins contained in the kernels as a starting point for the synthesis of corticosteroids. In writing of *Arachis hypogaea* there is no mention of the development of its protein as a source of textile fibre (e.g., Ardil). In the case of the cohune nut (*Attalea cohune*) the prospects of developing the shell (which represents nine-tenths of the nut) as a source of charcoal are not discussed. Although the cake derived from castor seed (*Ricinus communis*) is described as toxic, no mention is made of the processes which have been developed for removing its toxicity.

Some of the entries are a reflection of the thoroughness with which the author has searched the literature. Thus, Mezereon seeds (*Daphne mezereum*) yield 35-40 per cent. of a drying oil, a fact which seems to have escaped mention in either Eckey (*Vegetable Fats and Oils*) or in Hilditch (*The Chemical Constitution of Natural Fats*).

The dictionary proper is followed by an alphabetical index running into several pages giving the vernacular or other common names that are applied to the plants described in the main body of the work. Whilst this is useful, it is of limited value owing to the many alternative spellings which exist for vernacular names used by illiterate tribes.

The work provides a very useful summary of information available concerning common as well as very obscure oilseeds and can be recommended to workers who are likely to require information about little-known sources of fatty oils.

W.D.R.

DAIRY BACTERIOLOGY. By Bernard W. Hammer, Ph.D., D.Agr., and Frederick J. Babel, Ph.D. 4th Edition, ix + 614 pp., 9 × 6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall Ltd., 1957). Price 72*s.*

This book gives a comprehensive survey of the bacteriology of milk and milk products, and is divided into two sections.

The first section deals with the general bacteriology of milk, and describes and discusses plant and laboratory procedures in relation to the control of bacterial growth in milk. The second section has chapters describing in detail the bacteriology of the various dairy products, including cheese, butter, condensed and evaporated milk, milk powder and ice-cream.

Nearly ten years have elapsed since the third edition of this book appeared; consequently this new edition contains much additional material, reflecting the considerable advances that have been made in dairy bacteriology in the meantime. Three new chapters have been included, entitled "Bacteriology of Milk Production," "Freezing Milk" and "Cream and Milk Plant Operation", subjects which have become of increasing importance in recent years. New material has also been added to most of the original chapters, notably the effect of antibiotics and bacteriophages on lactic cultures, the milk enzymes and the bacteriology of cheese.

The lists of references, which have been considerably extended, should be of considerable use as a guide to further reading.

Although the book with its topics sub-divided into headed paragraphs, is mainly designed for students pursuing courses in dairy bacteriology, it should also be useful as a standard reference work.

D.H.

THE STRUCTURE OF MEAT ANIMALS. By Roderick MacGregor, F.R.C.V.S., M.R.S.I., M.I. of M. Students' Edition 1957. 238 pp., 8½ × 5½. (London: The Technical Press Ltd., 1957). Price 12*s.* 6*d.* net.

This book, which was first published in 1952 (price £1), has been much sought after by meat inspectors and students. Indeed the appearance of this "Students' Edition", in a cheaper form, is the result of a big demand for it by students; however, the text is unchanged.

It is a pity that there is no Author's Preface explaining these things, because after an interval of five years from the publication of the First Edition, a reader might reasonably imagine that some alterations or additions to the text had been made. The book is still available in a better binding for those who require it at a price of 21*s.*

L.H.G.-B.

ANALYTICAL MICROSCOPY: ITS AIMS AND METHODS IN RELATION TO FOODS, WATER, SPICES AND DRUGS. By T. E. Wallis, D.Sc., F.R.I.C., F.P.S., M.I.Biol. Hon. F.R.M.S. Second Edition, viii + 215 pp., 8½ × 5½. (London: J. & A. Churchill Ltd., 1957). Price 25*s.*

Anyone who is concerned with analytical microscopy or with the histology of foods and drugs could advantageously use this book. Descriptions of the structure of foods and drugs are not readily accessible: some volumes, such as Greenish and Collin's *Anatomical Atlas of Vegetable Powders*, are now out of print, and others, for example Gassner's *Mikroskopische Untersuchung pflanzlicher Nahrungs—und Genussmittel*, are expensive. Dr. Wallis's volume is really a supplement to works such as those mentioned, since it deals with typical operations used in analytical microscopy (sifting, sedimentation, the use of solvents, chemo-microscopy, staining and the like, as well as quantitative microscopy, measuring, drawing and related techniques). However, the volume is much more than a mere introduction to techniques: it includes numerous detailed drawings not easily found elsewhere such as those of common weeds and other seeds, insect pests in foods, the histology of culinary herbs, the diatoms, fungi and protozoa of water, pollen grains and fish scales. Various specialized matters of interest to the food chemist are also described. Thus, the irregular brown bodies found in the husk of the carob bean,

Ceratonia siliqua, are illustrated on page 120, the seeds of the white lúpin (sometimes used as a coffee adulterant) are illustrated on page 125, diagrams of the commercial varieties of sulphur are found on page 127 and a transverse section of the outer epidermis of *Plantago ovata* is drawn on page 145. Useful data (e.g. the weight of seeds, vein-islet numbers and the palisade ratio of leaves) and formulae for reagents are given as appendices. The general impression left is that when a difficult problem in microscopy has occurred it has been referred to Dr. Wallis, and that he has described the methods used for its solution in this book.

W.D.R.

ZOOGEOGRAPHY. By Philip J. Darlington, Jr. xi+675 pp., 9¼×6½. (London: Chapman and Hall, Ltd.; New York: John Wiley & Sons, Inc., 1957). Price 120*s*. net.

Books on Zoogeography and Phytogeography usually suffer from one or two shortcomings. Either they are too sketchy in fact, so that the reader may justifiably feel that the author has selected the material to fit his theories, or the facts form a large indigestible mass insufficiently leavened by the ideas. This book does neither, and is one of the most interesting of its kind seen by the reviewer. The facts concerning vertebrates—with which exclusively the book deals—are given both in readable account and convenient summary in chapters 2-6, and the evidence considered and theories drawn in the later chapters. The author's conclusions are novel in an unexpected way, for he neither builds land bridges nor (more fashionably perhaps) splits continents, preferring (as he puts it) to believe that the animals are more mobile than the land they live on. Evolution proceeding at a constant rate in two equally dense populations on two land masses, the numbers of new forms contributed by each land mass will (other things being equal) be in proportion to the sizes of the land masses; so that, in general, evolution has gone on mainly on the Old World continents, with Australia and the Americas receiving rather than contributing new forms over the "bridges" and chains of islands which exist today. The story is satisfying and well told.

The narrative suffers from the not uncommon transatlantic fault that it has too chatty an Introduction, with a surfeit of italics to mark the more important points. From chapter 2 until the final chapter on "Man" this style is, happily, dropped. The last part of the penultimate chapter on "The Past", where the author disinters again the decently buried theory of the moon's origin from the Pacific Ocean, is, however, surely a warning to all scientists to stay within their own disciplines unless they have read very widely. The final chapter on "Man" is pure fantasy and should be cut out in future editions; the story on p. 638 of the *Aedes* mosquito and yellow fever, which latter "fortunately never reached the Old World" leaves one wondering (a) if the author has a private definition of "Old World" or (b) if he has ever read any "Old World" literature on tropical diseases. This statement at least should be corrected forthwith, for if it is seen by anyone from the African continent, where the disease is now endemic, the whole book may well be condemned on its account, which would be a pity.

This is a valuable contribution to zoogeography, but would be better if the author kept more strictly within the boundaries of his own subject: the distribution of vertebrates on the world's surface.

K.W.J.

ANNUAL REVIEW OF BIOCHEMISTRY. Vol. 26, 1957. Edited by J. Murray Luck. ix + 768 pp., 9 × 6½. (Palo Alto, California: Annual Reviews, Inc., 1957). Price $7.50.

Volume 26 of this series of Annual Reviews follows the format of its predecessors, and owing to the dynamic nature of the subject, the selection of material for inclusion must become a more formidable problem as each year passes.

Following the now customary prefatory chapter, which is from the pen of Sir Rudolph Peters, there are chapters on biological oxidations; non-oxidative non-proteolytic enzymes; proteolytic enzymes; metabolism of lipides; carbohydrate metabolism; water-soluble vitamins; fat-soluble vitamins; nutrition;

X-ray studies of compounds of biological interest; the chemistry of proteins; amino-acid and protein metabolism; the nucleic acids; biochemistry of the steroid hormones; haem pigments and porphyrins; clinical applications of biochemistry; biochemistry in the U.S.S.R.; chemistry of the carbohydrates; the biochemistry of muscle and a short list of cross-references to other reviews of biochemical interest.

Each chapter is rendered complete by a list of references cited in the text and, as usual with this series, comprehensive author and subject indexes are provided at the end of the book. This work ably maintains the high standard now expected of *Annual Review of Biochemistry* and the editor's insistence that the reviews shall be critical appraisals rather than synoptic summaries gives an added value to this valuable reference series.

T.J.C.

ELEMENTARY SOIL AND WATER ENGINEERING. By G. O. Schwab and R. K. Frevert and Others. viii + 296 pp., 8¾ × 5¾. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall Ltd., 1957). Price 50*s*. net.

This is a book which should be found most useful to all agricultural students who intend to work in such fields of agriculture as erosion control, drainage or irrigation. The eighteen chapters cover, in sequence, the preparation of field notes, simple surveying and mapping, rainfall and run-off, soil erosion, contour cropping, rivers and waterways, erosion, drainage, irrigation and soil conservation farming. Each chapter is adequately illustrated with diagrams and photographs and a list of references to original sources of information, together with set problems, completes each chapter. Further problems of a practical nature appear at the end of the book, together with a glossary and subject index. Although the book is intended for the student it should also prove of value to engineers, farmers and indeed any worker engaged in engineering problems connected with farming. The price, however, is unfortunately high for a work of this type.

P.C.C.

FUNDAMENTALS OF SOIL SCIENCE. By C. E. Millar, L. M. Turk and H. D. Foth. Third Edition, x + 526 pp., 9¼ × 6¼. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall Ltd., 1958). Price 62*s*. net.

This new edition is a complete revision of the second edition, published in 1951 and includes the results of further advances made over the last six years. More emphasis has been placed on such factors as soil texture, clay minerals, and the soil profile.

The work follows closely the pattern of other well-known American soil science text-books written primarily for the agricultural student. Naturally, the information given on soil type, irrigation practices and erosion control has an American bias which is of doubtful value to those readers outside the United States. The subject matter is, however, well presented and illustrated. A four-page glossary and a subject index conclude the work.

P.C.C.

A HANDBOOK ON NIGERIAN HIDES AND SKINS. By I. Mann. 53 pp., 9½ × 7. (Kaduna, Northern Region, Nigeria: The Government Printer; London: The Crown Agents for Overseas Governments and Administration, 1957). Price 9*d*. net.

Hides and skins appear high in the table of Nigeria's principal exports. In recent years the value of the hides and skins exported has been just over £3 million, representing the export of 1,000,000 hides, 5,000,000 goat-skins, and 80,000 sheep skins. The aim of the Government is to maintain this trade and, if possible, improve it in the face of increasing competition and a falling world market. This can only be achieved by exporting products of improved quality, and to effect this improvement requires the continued efforts of an educational and advisory service throughout the chain of production, from the small up-country villages to the larger markets.

The Government invited Dr. Mann to visit Nigeria in 1954 and to comment *inter alia* upon the hides and skins industry. Subsequently, he revised his well-known treatise, *A Handbook on Hides and Skins*, to suit local conditions in Nigeria; it is this revised edition which has now been published.

This book is divided into seven Sections and comprises twenty-five Chapters and two Appendices. The first two Sections are of an introductory character dealing with the structure and functions of the hide or skin and how it is tanned, and the various kinds of damage it can sustain which affect its value. There are also chapters on malpractices and adulteration, and used hides. Section III describes in detail the correct methods to use in the preparation of hides and skins—killing, flaying, cleaning, drying, preservation and storage—and constitutes one of the most important Sections in the book. Then follows Section IV which is devoted to the grading of hides and skins, the buyer, prices and selection, and Section V, which deals with the tools of the trade, drying sheds and stores. Camel hides and the preparation of reptile skins receive some attention in Section VI and by-products are dealt with in Section VII. A useful table for controlling the strength of the arsenic dip appears in Appendix I and a grading form for cattle hides is shown in Appendix II.

The work would be improved if it were dated, like its predecessor, and if the pages on which the many illustrations appear were numbered and the page numbers were shown in the list of illustrations at the beginning of the book. It is also thought that Section V follows naturally after Section III and should, therefore, be moved to Section IV in future editions. These are relatively small matters, however, in a book which will undoubtedly be of value to the Nigerian Veterinary Service and many others.

L.H.G.-B.

BOOKS RECEIVED FOR NOTICE

THE NORTH-WEST MEAT TRADE ANNUAL AND DIRECTORY OF ANIMAL BY-PRODUCTS. 257 pp., 8¾×5¾. (London: Wheatland Journals Ltd., 1957). Price 21*s*.

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Compiled by Miss V. Clarke

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Publications of the U.S. Departments of Agriculture and Commerce are obtainable from Superintendent of Documents, U.S. Government Printing Office, Washington 25, *D.C., U.S.A., or from H. M. Stationery Office, London.*

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